Civil Engineering and Contracting.

March 16, 1922

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Huge Water Supply Scheme Proposed for Northern New Jersey

Current Practice in Railway Curve Superelevation and Maintenance

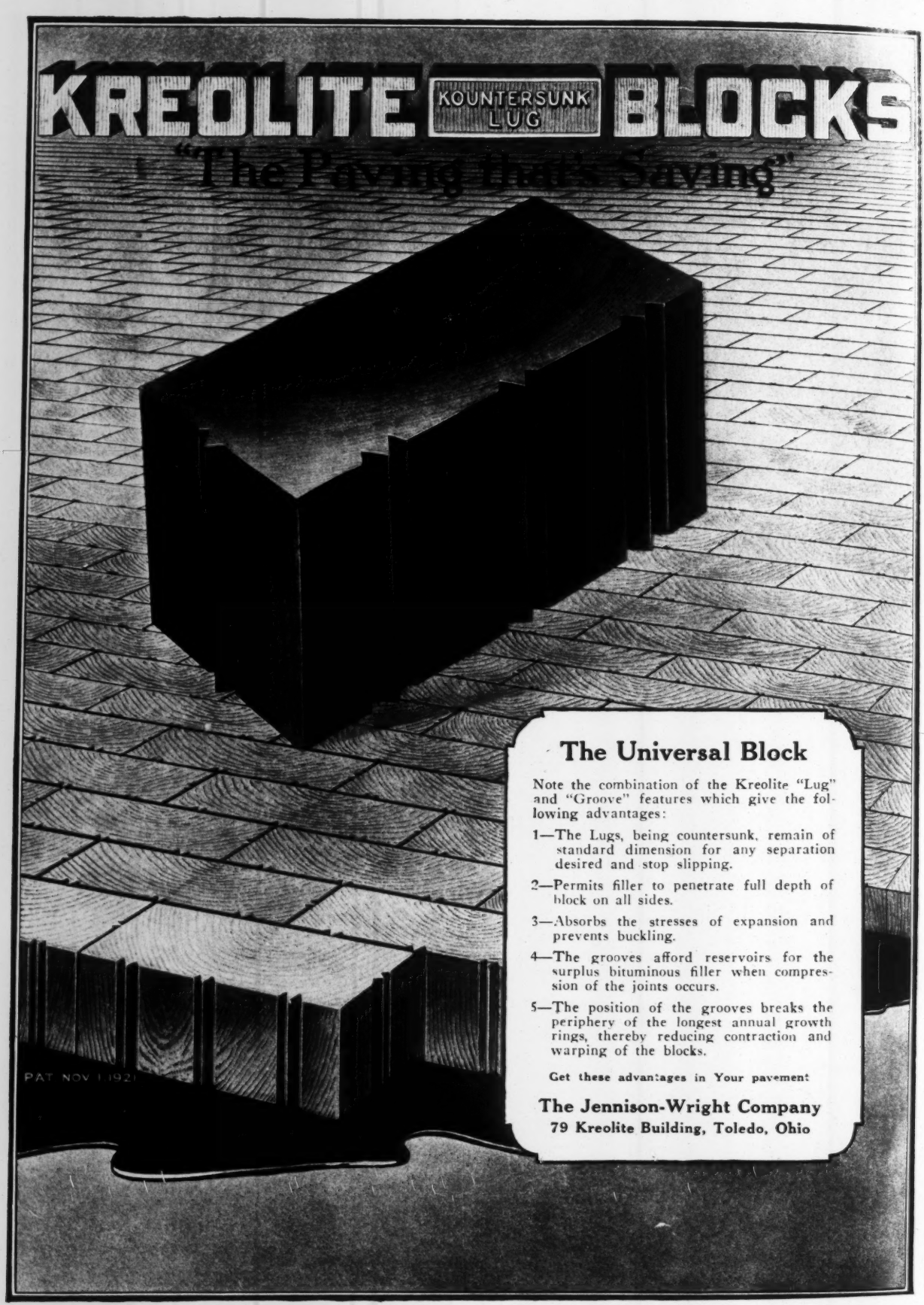
Wind Pressures on Radio Towers

By R. Fleming

Some Facts Regarding Tides and Their Engineering Importance

By G. T. Rude

Movable Form Used in Building 22-Foot Dam at Danville, Ill.



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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Zoning at Philadelphia

COMMENDABLE in all respects is the action of the Philadelphia engineering and other organizations that joined in calling a recent meeting to consider the local zoning situation. A proposed zoning ordinance has been blocked in the City Council, apparently in large part because of a lack of educational publicity. The Philadelphia Engineers' Club is now exhibiting the zoning maps. This and the joint meeting should help on a project which, to say the least, should not be killed by local apathy at a time when scores of cities are giving warm approval to zoning.

Information on Tides

TIDES are natural phenomena on which the average engineer is little informed beyond the common knowledge of their occurrence and some information on peculiarities at specific localities. Most engineers, for instance, probably believe they are regularly of semi-diurnal recurrence. And yet, as Mr. Rude shows in the informing article on another page, they are of several types with most interesting differences. His clear explanation of the fundamentals of their behavior and the uses to which their study may be put should be read by all engineers who are concerned with marine work and should give a greater appreciation of the work the Coast and Geodetic Survey is doing in tidal investigation and recording.

A Research Opportunity

ANOTHER of the many deficiencies in our stock of engineering data is brought to attention in this issue, in connection with the subject of radio towers. We know little or nothing about wind pressures at some height above ground, and apart from a few measurements of negligible value, are compelled to rely on the common impression that up aloft, where the wind has a free sweep, it blows harder than near the ground, just as a fluid stream moves more rapidly at a distance from the retarding influence of walls. But this is nothing more than an impression, and, especially as we are concerned with maximum rather than with normal velocities, it may be that the same figures hold for ground level and for 1,000 ft. elevation. There is an excellent opportunity for research here. We can get along for a time on arbitrary rules, such as the convenient one proposed by Mr. Fleming. But surely a makeshift rule is no lasting substitute for measured fact.

Re-Study of Wind Pressure

IF RESEARCH in the field of wind pressures on towers is entered upon, it should by all means have combined with it a general re-study of wind effects on engineering structures. The existing data are incomplete, unco-ordinated, and old. There is a mass of anemometer readings in our Weather Bureau records largely undigested, but no one has yet succeeded in translating them satisfactorily into terms of pressure on engineering structures. An anemometer measures the integrated wind movement at a particular point close above the roof of a particular building; this tells of the movement of a single air filament, regardless of pulsation, of change in direction, or of lateral extent. We conclude from such records and from scattered pressure tests that probably the greatest horizontal pressure to be expected in ordinary inland locations is about 30 lb. per square foot on a fixed flat object, large or small —a fairly definite conclusion resting on a surprisingly uncertain foundation. On the basis of conclusions of this kind we daily spend great sums of money in providing against wind pressure. A moderate expenditure for re-investigation of the subject, from the engineer's not the meterologist's, standpoint, would enable us to tell whether these sums are spent properly and economically. Such a research investment promises to pay substantial dividends.

Showing Up an Industrial "Spook"

PERPETUAL motion appears to be just about as elusive in commercial affairs as we have found it to be in matters physical. Consider the bugaboo of German competition. So long as the rôle of Germany in foreign markets was to sell, her cheap money was all in her favor. But now, we are told, she has practically exhausted the stocks of raw materials that were bought abroad before the recent decline of the mark. Now she must enter the world's market place as a buyer, and that cheap money doesn't look so good. It appears, too, that even Germany cannot emerge from a World War stronger and more efficient industrially. No less an authority than Dr. Siemens, head of Siemens-Halske, has told his stockholders, according to a New York *Times* dispatch that under equal conditions German industry could no longer compete in world markets. Her loss of productivity, Dr. Siemens says, "is momentarily concealed by the difference between the purchasing power of the mark at home and abroad." So much twaddle has been circulated concerning this superhuman competition which is to overwhelm us, that it might be worth while for American business men to stop right now, stoop and hook their fingers securely in their shoe-straps and try to lift themselves to their desktops. Then, when they have satisfied themselves that it can't be done, they may take heart and "carry on."

Curing Pavement With Chemicals

ILLINOIS' successful experience last season with calcium chloride for curing concrete pavements is of direct interest to highway contractors. As related in the last issue, a sprinkling of granular chloride amounting to less than 4 lb. per square yard makes it

unnecessary to use water, in excess of that contained in the concrete, for tempering and hardening. One of the objections to wet-batch haulage as a construction method has been that about as much pipe-line work and pumping equipment are required merely to supply water to cure the slab as are necessary when dry batches are hauled and the concrete is mixed on the grade. The new method of curing eliminates this objection. It also does away with sprinkling, ponding or earth carpeting, with subsequent cleaning of the cured slab, when the mixing is done on the grade. Finally the curing process is shortened and the contractor does not have to guard his finished work so long against damage from trespassers and he can put it in service sooner for hauling in supplies and materials if his method of operation makes this use desirable. Altogether the new process promises to simplify the work of pavement construction, besides, it appears likely, producing a structurally improved pavement. Its cost is astonishingly small. One objection only—that a heavy rain will wash away the curing application—leaves any doubt of the usefulness of the process according to the statement of experience.

French Coefficient Not Important

PAST persistence in clinging to high wearing qualities for the coarse aggregate for concrete roads appears to have been largely a waste of energy. At the convention of the Associated General Contractors a resolution was passed by the highway contracting section urging engineers to raise the percentage of permissible wear so as to make available a greater number of aggregates and thus frequently eliminate the expense of importing stone merely to satisfy French coefficient values based on macadam road practice. Gradually too a number of state highway commissions have been cautiously permitting higher and higher percentages of wear, and placing French coefficients in the background, when writing specifications. Finally there comes from the structural materials research laboratory at Lewis Institute a report sponsored by Prof. D. A. Abrams, as is noted briefly in this issue, that percentage of wear has little significance when applied to aggregates for concrete roads. Any reduction in the requirements for aggregates which will make a greater number of pits and quarries available to the concrete road builder is bound to reduce costs. Will it reduce quality? The swing of thought seems to be toward a general opinion among highway engineers that it will not. Probably before this opinion is allowed to crystallize it will be well to learn more from the investigations now under way of the effect on impact stresses of small surface irregularities, such as are produced by moderate wear. Tentatively, however, a reduction of the wear requirements of aggregates for concrete roads is sound procedure if it enlarges opportunities for wayside materials supplies or increases the number of commercial producers who can supply the work.

Increase in Motor Vehicles

PRELIMINARY figures just issued by the U. S. Bureau of Public Roads indicate that the motor-vehicle registration in the United States for the year 1921 was approximately 10,325,000, based upon returns from all but three states, for which an estimate of last year's registration was made. The 1920 figures, as reported in *Engineering News-Record*, April 21, 1921, p. 683, showed a total of 9,211,295 vehicles. The 1921 total, therefore, represents an increase of 12 per cent over the number of vehicles reported for 1920. To highway engineers this result is significant, for it comes at the end of a period during which all reports indicated that the motor-vehicle industry had experienced a decided slump. Yet in spite of this depression there were placed upon the country's highways in 1921 a million more motor vehicles than were operated during the previous year. A comparison of the total revenue from the registration fees—$125,000,000 in 1921 as against $102,034,106 in 1920—is worth noting. The increase of almost $23,000,000 represents a gain of 22 per cent as against a gain of 12 per cent in the number of vehicles. This comparison indicates clearly the trend in motor vehicle legislation toward higher license fees for both automobiles and motor trucks. During the past year the opinion has sometimes been expressed that, so far as motor vehicles were concerned, the country had about reached its saturation point. The figures just issued by the U. S. Bureau of Public Roads disprove this belief. They demonstrate again the necessity for continuing policies of highway development and a steady supply of funds for carrying out the federal aid highway system.

Curves and Train Resistance Tests

SINCE railway curves constitute an appreciable part of track mileage their maintenance in proper condition for traffic is a matter of economic and practical importance. Curves have an important influence on the loading and smooth riding of trains and the wear of equipment. They are also the cause of much additional expense in wear of material and maintenance of track as compared with similar expense on straight line. A recent review of curve practice on a number of railway systems, started on p. 446, shows enough variation in practice to suggest the desirability of investigation as to the sufficiency of the principles on which present practice is based.

Formulas and rules now employed in problems where train speed and train resistance are functions are based mainly upon tests and investigations made many years ago. To what extent these formulas and rules are applicable to or should be modified for present conditions is a question. For instance, formulas for determining the superelevation of rails on curves are found in many cases to give excessive figures, even allowing for the fact that they serve only as a guide in practical application. In general, therefore, the elevation is determined on the basis of custom, experience and observation rather than upon scientific analysis or calculation.

Similarly, the locomotive constitutes no factor in the above formulas. But the long and heavy locomotives of today are decidedly a factor in the practical adjustment of both elevation and gage on curves in order to secure safe and easy riding track which is economical in maintenance. Compensation of grades for curvature is another problem whose solution is based largely on old records.

New tests and investigations of train resistance in its various aspects appear to be desirable. The work of the late A. M. Wellington is classic and is the basis of much present practice, but it seems to require so much modification under present conditions as to indicate a field for further investigation. Herein lies an opportunity for research.

Two District Water-Supply Projects

RARELY within two weeks does an engineering journal have an opportunity to present the outstanding features of two such important water-supply reports as the recent ones on the water-supply needs and possibilities of the Massachusetts and New Jersey Metropolitan Districts. The Massachusetts report, abstracted in the issue of March 2, p. 360, outlines a project for adding 500 m.g.d. to the present available supply of Boston and associated municipalities in order to meet the needs of the next 50 years. The New Jersey report, as shown elsewhere in this issue, places the needs of Newark, Jersey City, Hoboken, Paterson, and various other municipalities in six counties at 820 m.g.d. 50 years hence, or some 550 m.g.s. in excess of the safe yield of the present sources of supply. The Massachusetts project has possibilities of extension that are outlined rather vaguely, although sufficiently in view of governing conditions. The New Jersey report presents four separate projects from which a choice may be made to meet the needs of the next 50 years, and outlines possible combinations and extensions, including an extension to the Delaware River, that would yield three times the estimated needs of fifty years hence, or nearly ten times the amount of water consumed by the New Jersey Metropolitan District in 1920.

The Massachusetts report proposes a single storage reservoir of 410 billion gallons capacity. The largest storage reservoir in any one of the four New Jersey projects has a capacity of 328 billion gallons, but this reservoir would be supplemented by others to be added from time to time. One of the New Jersey storage projects would solve the Passaic Valley flood problem, and a second one (and the one which seems most likely of the four to be adopted) would contribute materially to its solution.

The Massachusetts report contemplates no filtration for the immediate present, either of existing or the proposed additional supply, although looking forward ultimately and indefinitely to the filtration of water from all surface sources. The New Jersey report includes estimates for filtration of all the water to be taken from additional sources of supply. This particular difference is due in part to different local governing physical conditions and in part to the well-known Massachusetts tradition in favor of sources of water supply that do not require filtration.

A marked contrast between the Massachusetts and the New Jersey projects is that the former proposes to use the higher stream flows only (run-off in excess of 1.2 sec.-ft. per square mile, or about 775,000 gal. per square mile per year) while the New Jersey projects contemplate taking as much as is feasible of the entire run-off without encroaching upon existing water rights and the need for maintaining a minimum dry weather flow for purposes of stream sanitation. This difference also in the Massachusetts and New Jersey reports is in considerable part explainable by local conditions.

Another remarkable difference in local conditions deserves mention. In Massachusetts a metropolitan district authority has been in existence twenty-five years. It supplies water, by wholesale, to the various municipalities in the district, all or practically all of which own and operate their own water-works. In New Jersey such a metropolitan water district as the recent report suggests does not exist. True, there are several joint systems of water supply in the New Jersey Metropolitan District, but the most notable of these are under private ownership. The East Jersey Water Co. and its associated companies supply a number of municipalities, either wholesale or to individual consumers. The Hackensack Water Co. supplies Hoboken by wholesale and some fifty other municipalities, direct. There are four or five other companies that supply together something like thirty municipalities in the New Jersey district. Newark and Jersey City own and operate their own supplies, but these were developed by and purchased from the East Jersey Water Co. many years ago.

Although, as has just been stated, a New Jersey Metropolitan District would have to be created, it should be noted that there is in existence a North Jersey District Water Supply Commission and a corresponding district taking in all the northern counties of the state. This commission has power to acquire or construct water-works for the supply of such municipalities as may, either singly or collectively, contract with it for that purpose. The New Jersey report, however, suggests an entirely new commission, a state board with power to issue state bonds. This (the report does not bring out) would require additional legislation and besides that it would be necessary to have a state-wide referendum, owing to a constitutional prohibition of state bond issues in excess of $100,000 unless approved by the voters of the whole state.

The New Jersey report suggests as a model to be followed the Massachusetts Metropolitan Water District plan. This resulted from a report made in 1895 by the Massachusetts State Board of Health. Eleven years earlier, or in 1884, the New Jersey Water Supply Commission, created in 1882, recommended a joint water-supply plan under which ten cities and towns, including Jersey City and Newark, would have been provided with a joint water supply from the Pequannock River—later developed by the East Jersey Water Co. for Newark. How this plan came to naught is too long a story to be told here, but the story, together with many other interesting details, may be found in a lengthy editorial review entitled "Water Supply of Northeastern New Jersey and the Jersey City Bid," covering in some of its ramifications a period of more than a century, published in *Engineering News*, Apr. 25, 1895. It may be added that " the Jersey City bid" that forms a part of the title quoted was one of a half dozen or so in as many years made in the long struggle over a new water supply for Jersey City which finally resulted in the present gravity system from the Boonton reservoir on the Rockaway River—a struggle which in some of its phases and later developments has continued for about thirty years, and which is only one of many water conflicts in this territory, some of which are still being fought.

These conflicts have nothing to do with the physical aspects of the projects outlined in the New Jersey report, but they do raise some serious questions in connection with the final solution of the water-supply problem of northeastern New Jersey. The entire problem will never be solved until it is handled in a broad public-spirited way, with co-operation on the part of the state, the several municipalities, and the various private interests concerned. Mr. Hazen's admirable report presents such remarkable and desirable possibilities that it should stimulate this essential co-operation.

Huge Water Storage Projects for New Jersey District

Any One of Four Plans by Allen Hazen Would Give Supply for Several Decades—Combinations of Reservoirs and Delaware River Flow Would Yield Three Times 1970 Needs

TWO and one-half billion gallons of water daily, or three times the need of the 5,600,000 estimated population to be supplied in 1970 by the 33 water-works systems now operating in the six counties on the west side of the Hudson River, could readily be provided for wholesale delivery to the several works by a New Jersey Metropolitan Water Board of three capable men empowered to take over existing sources of supply, enlarge them to their full capacity and supplement them with new developments, according to a report by Hazen, Whipple & Fuller, civil engineers, New York City, to the State Department of Conservation and Development of New Jersey. Of the 2,500 m.g.d. mentioned, 1,661 m.g.d. would come from three large storage systems on the Passaic and Raritan rivers and smaller streams to the north and west combined with the Hackensack and a number of minor sources, and 839 m.g.d. would be pumped from the Delaware River "in winter, so as completely to fill reservoirs" in the Passaic and Raritan storage systems "holding 635 billion gallons." Included in the 1,661 m.g.d. are over 300 m.g.d. already developed or being developed, chiefly from the Passaic and its tributaries. The entire 2,500 m.g.d. "is more than ten times the present rate of output" of the 33 water-works systems, which is 244 m.g.d. for a population of 2,070,000.

All the 2,500 m.g.d. except 40 m.g.d. would be filtered. Each of the three large proposed storage reservoirs is near the district to be supplied, the most remote (the Raritan) requiring an aqueduct only 32 miles long, while the aqueduct from the upper Passaic or Long Hill system would be only 19 miles long, terminating in Jersey City, but passing under Newark en route. Each Passaic reservoir would deliver water to considerable low service areas by gravity, but the Raritan water would be under only 80-ft. head at tidewater. Besides the three storage systems already named, estimates were made for a large reservoir on the Wading and Mullica Rivers, in South Jersey, but while this would yield 316 m.g.d., the water would have to be lifted 200 ft. through 12 miles of steel mains, then conveyed 72 miles additional through a 13-ft. aqueduct, and at the Newark terminal the delivery head would be only 80 ft. above tidewater, also for the Raritan aqueduct.

Two Passaic Projects Lead—Since the estimated need of the New Jersey Metropolitan District up to 1970 is for only 820 m.g.d. and since either one of the Passaic projects when combined with the safe future yields from existing sources outside these projects would come within less than 100 m.g.d. of that amount, and since the Passaic projects are so far superior to the Raritan and Mullica projects, little further consideration will be given here to the two last named or to pumping water from the Delaware River. As will be shown further on, the upper Passaic or Long Hill reservoir system, including the supplementary reservoirs to the westward, is superior to the lower Passaic or Passaic Great Reservoir project from a water-works viewpoint solely, but the latter would serve not only for water-supply purposes, but would also solve the very serious Passaic flood problems and eliminate a large mosquito breeding area. Moreover, the Long Hill system, combined with existing and proposed developments in the area tributary to the Passaic Great Reservoir, would supply 859 m.g.d., which with the 101 m.g.d. of existing sources of supply outside the Passaic gathering grounds would give 960 m.g.d., as against the 820 m.g.d. needed in 1970.

The principal communities in the New Jersey Metropolitan District are Newark, Jersey City, Bayonne, Hoboken, Paterson, Passaic, Montclair, the Oranges, Elizabeth and Plainfield. The East Jersey Water Co. and allied companies supply a considerable number of places either directly or wholesale from the Little Falls filter plant on the Passaic River and the Hackensack Water Co. sells water at wholesale to Hoboken and at retail to some fifty other cities and towns. Newark and Jersey City have their own supplies. Plainfield, Elizabeth and a number of other places in the south

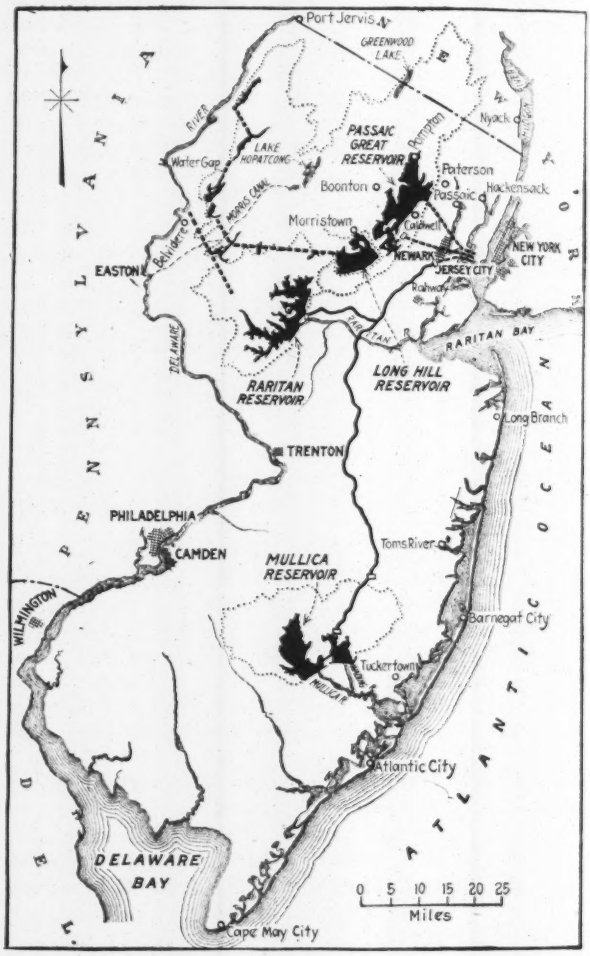


FIG. 1. FOUR POSSIBLE ADDITIONAL WATER-SUPPLIES FOR NEW JERSEY METROPOLITAN DISTRICT

Any one of these, combined with existing sources, would serve the district for decades to come without recourse to one of the Delaware River plans.

part of the district depend upon four or five companies for water.

Water Consumption and Industrial Supplies—Of 283,777 services in the district, 205,361 or 72 per cent are metered. The per capita consumption in 1920 was 118 gal. For 12 systems having altogether 94 per cent of their taps metered the per capita water consumption in 1920 was 89 against 154 for 21 systems having but 49 per cent of metered taps. The population in the heavily metered group was 1,139,753 against 930,729 in the other group. The population supplied by public owned works was slightly under and that privately supplied a little above 1,000,000. The public works had 66 per cent of their taps metered and a consumption of 139 gal. per capita compared with 77 per cent and 99 gal. for the private works. Complete metering, Mr. Hazen says, might reduce the per capita rate from 118 to 100 gal. He assumes that the per capita consumption will still be 118 gal. in 1930, and that it will rise to 123 in 1940 and will reach 147 in 1970. Meanwhile he assumes that the supply of water for industrial purposes contributed by the industries themselves will fall from the present 19 gal. to 11 gal. per head of total population; or the present total requirement of 137 gal. per capita will be 158 gal. in 1970, of which the proposed district will supply but 147 gal.

Leaving industrially owned water supplies out of account, Mr. Hazen estimates that the present water consumption is divided as follows: domestic and public uses, 38 per cent; industrial, including supplies to railways and steamships, 32; waste due to leaky pipes and plumbing and unmetered services, 30 per cent.

Population increase from 1920 to 1970 in the six counties of the New Jersey Metropolitan District is estimated by Mr. Hazen as 1.95 per cent annually. The actual annual increases in the decade 1910-20 was 2.45, while in the four decades from 1870-1910 it was 3.4 per cent.

Existing Sources—The chief existing source of water supply in the New Jersey Metropolitan District is the Passaic River and tributaries, which have been developed to a safe yield of 164 m.g.d., and the Hackensack, which might yield 41 m.g.d. in 1970. The 164 m.g.d. yield on the Passaic and the Hackensack is thus provided: 57 m.g.d. by storage on the Pequannock tributary for Newark, another 57 m.g.d. by storage on the Rockaway for Jersey City, and 50 m.g.d., without storage, from the main Passaic at the pumping and filtration plant of the East Jersey and allied companies at Little Falls. Besides this 164 m.g.d. already provided, storage up to some 50 m.g.d. (of a possible 70 m.g.d. or more) is being developed on the Wanaque, for Newark, by the North Jersey District Water Supply Commission, and Bayonne has an application for storage rights on the Ramapo, the most eastern tributary of the Passaic, while there are opportunities for more storage on some of these tributaries. Of the headwaters, there remain practically untouched the Ramapo, already mentioned, and the main stem of the Passaic, which offers an opportunity for a reservoir site that would conserve all the run-off above the dam as well as store the yield of many streams farther away. The undeveloped flow of the upper main Passaic and all the tributaries mentioned now passes the East Jersey plant at Little Falls. The catchment area above this point is 761.2 miles, but the safe yield now available, after allowing for the sanitary and other needs down the river, is only the 50 m.g.d. already mentioned. A dam just above Little Falls would provide a storage reservoir of immense area and large volume, extending back almost to the possible reservoir on the main river, already mentioned. Either one of these reservoirs combined with the Passaic catchment areas for which storage has already been or is being provided, and with the Hackensack River and other sources, would supply more water than would be needed for more than half a century to come.

Maps and Tabular Data—Before taking up the two Passaic storage reservoir proposals in brief detail, it may be stated that the location of the four storage system possibilities reported on by Mr. Hazen is shown on the accompanying sketch map of the State of New Jersey and that various comparative data for the four systems are given in three tables reprinted here from Mr. Hazen's report. Table I gives the length of the various proposed main dams at the flow line, and for each reservoir its maximum and average depth, water surface area, water elevation at flow line and low water, and capacity to the bottom and also for the portion of the reservoir available. Table II compares the cost of the four reservoir and associated aqueduct systems, by construction and other elements, by totals and in unit cost per million gallon daily capacity. Table III is a cost estimate for the Long Hill system arranged progressively in order of development, beginning with the main reservoir, filters and conduit, and then continuing step by step to include additional reservoirs and tunnels to the westward, this latter installment bringing the total cost up to $122,909,000, and finally extending by means of pumps, filters and tunnels to take in 131 m.g.d. from

TABLE I. COMPARISONS OF FOUR STORAGE SYSTEMS

Name	Length of Main Dam at Flow Line, Ft.	Depth of Water Feet Max.	Depth of Water Feet Ave.	Area of Water Surface, Sq. Miles	Elevation Flow Line	Elevation Low Water	Capacity in Billion Gallons To Bottom	Capacity in Billion Gallons Available
Flat Brook	1,160	120	49	3.90	480	445	40	24
Paulinskill	600	105	23	3.80	460	433	18	13
Beaver Brook	1,430	85	26	4.70	440	413	26	18
Pequest	1,100	60	28	1.70	435	405	10	8
Musconetcong	1,400	70	22	2.90	420	390	13	10
So. Br. Raritan	610	30	9	0.60	505	475	1	1
No. Br. Raritan	1,500	100	38	0.52	335	310	4	2
Long Hill Res.	850	105	64	24.50	320	280	328	182
Passaic at Little Falls	7,700	42	22	61.50	200	180	290	220
Raritan	12,360	90	29	48.50	140	120	295	157
Mullica and Wading Rivers	33,400	30	12	53.80	40	25	140	106

TABLE II. RELATIVE COST OF FOUR PROJECTS
All in Millions of Dollars Except Cost Line

	Passaic Great Reservoir	Long Hill System	Raritan	Mullica and Wading Rivers
Sites and damages	39	24	21	3
Dams and reservoirs	10	15	12	11
Aqueducts	0	0	21	44
Collecting tunnels		20		
Pressure tunnels or equivalent	13	23	5	4
Filters	11	19	10	8
Pumping stations	4	2	7	13
Other structures		5	3	3
Engineering, administration and contingencies	16	22	16	17
Total cost of works	93	130	95	103
One-half capitalized pumping cost	8	0	15	22
Total cost	101	130	110	125
Capacity m.g.d.	450*	750	400	300
Cost per m.g.d. capacity	$225,000	$173,000	$275,000	$417,000

*In addition to 200 m.g.d. now obtained and to be obtained from this source by smaller developments and not counting a flow of 80 m.g.d. assumed to be maintained at Great Falls for the benefit of manufacturers and the lower river.

FIG. 3. THE LONG HILL RESERVOIRS AND AQUEDUCTS

The Long Hill reservoir alone would have an area of 24 sq. miles and store 328 billion gallons. Minor reservoirs would be built as required and altogether would add 112 billion gallons of storage. Ultimately water could be pumped from the Delaware River to the farther reservoir and flow thence by gravity to the main reservoir.

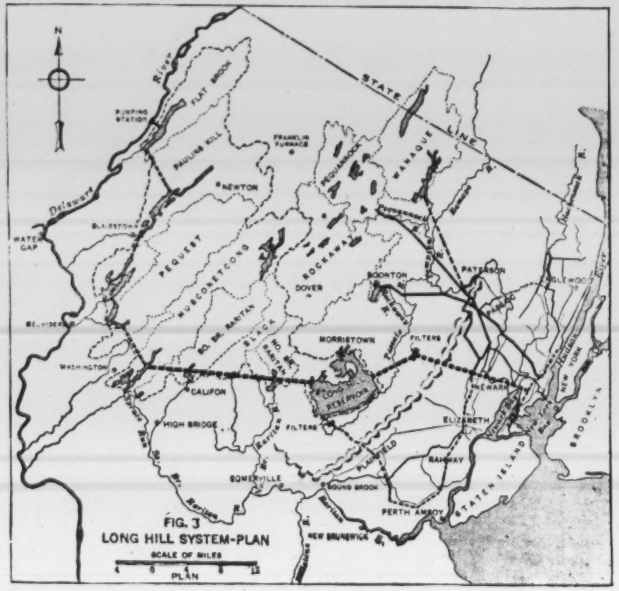


FIG. 3
LONG HILL SYSTEM-PLAN

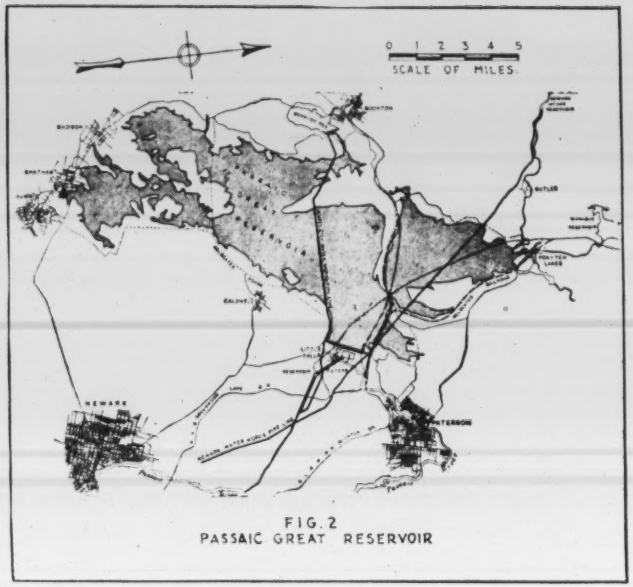


FIG. 2
PASSAIC GREAT RESERVOIR

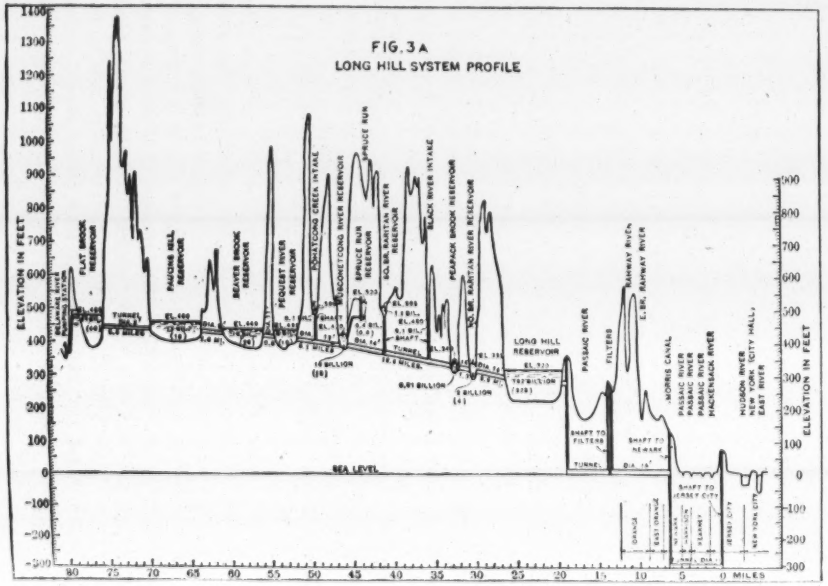
FIG. 2. PASSAIC GREAT RESERVOIR AND PRESENT CONDUITS

This reservoir would have an area of 61.5 sq. miles, and store 290 billion gallons of water. It would solve not only the water-supply but also the Passaic flood problem. It would submerge the Newark pipe lines from the Pequannock and the Jersey City conduit from the Rockaway and many miles of rail road and highway.

FIG. 4. EXISTING AND PROPOSED CONDUITS IN NEW JERSEY METROPOLITAN WATER DISTRICT

A 19-mile pressure tunnel and various pipe lines would connect the Long Hill Reservoir with the existing pipe lines of the 33 municipal and private water-works systems in the district.

(BELOW) FIG. 3A. PROFILE OF LONG HILL SYSTEM



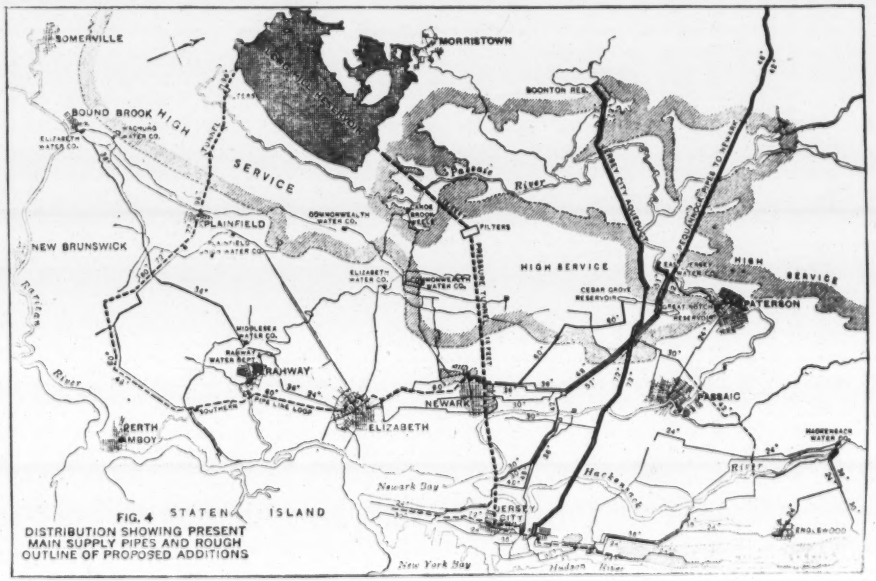


FIG. 4 STATEN ISLAND
DISTRIBUTION SHOWING PRESENT MAIN SUPPLY PIPES AND ROUGH OUTLINE OF PROPOSED ADDITIONS

the Delaware River, bringing the total supply developed to this point up to 750 m.g.d. and the total cost to $129,571,000, and making a corresponding unit cost of $172,000 for each million gallons daily supplied. In addition to the sketch map of the entire state already mentioned, Fig. 2 is a map of the Great Passaic Reservoir from the proposed dam, just above Little Falls; Fig. 3 shows the Long Hill reservoir on the upper Passaic above Millington, together with the tributary reservoirs further

TABLE III. SUCCESSIVE DEVELOPMENT COSTS, LONG HILL RESERVOIR AND DELAWARE RIVER PUMPING PROJECT

Long Hill Reservoir	$16,045,000	
Southern loop, extending to Newark with filters	7,410,000	
42 m.g.d. @ $558,000		$23,455,000
Filters for North Branch and Black River division	$3,000,000	
Reservoir and tunnel	12,402,000	
109 m.g.d. @ $357,000		38,857,000
Pressure tunnel, to Newark and Jersey City	$27,538,000	
Filters for So. Branch Division	1,560,000	
Reservoir and tunnel	7,085,000	
168 m.g.d. @ $446,000		75,040,000
Filters for Museconetcong division	$3,900,000	
Reservoir and tunnel	10,939,000	
300 m.g.d. @ $300,000		89,879,000
Filters for Pequest division	$3,240,000	
Reservoir and tunnel	8,263,000	
417 m.g.d. @ $243,000		101,382,000
Filters for Beaver and Paulinskill division	$4,116,000	
Reservoirs and tunnels	9,981,000	
558 m.g.d. @ $207,000		115,479,000
Filters for Flat Brook division	$1,680,000	
Reservoir and tunnel	5,750,000	
619 m.g.d. @ $199,000		122,909,000
Filters for Delaware division	$3,800,000	
Tunnel and pumps	2,862,000	
750 m.g.d. @ $172,000		129,571,000

It is assumed that the southern loop, or a part of it, will be first built; and that the first water will be distributed through it; and that the pressure tunnel to Newark and Jersey City will not be built until somewhat later. In the interval it may be that there will sometime be more water available in Long Hill Reservoir than can be distributed through the southern loop. This will depend upon how large that loop is made and what extensions of it there may be before the pressure tunnel is built. In this interval, if the Little Falls facilities permitted, water could be released from the Long Hill Reservoir to flow down through natural channels to the Little Falls plant and be utilized in that way.

This is another interesting matter. The yield of its own catchment area is so small that by itself years would be required to fill Long Hill Reservoir. With some of the feeders diverted to it the filling time would be reduced.

west and north, and Fig. 4 shows the main aqueducts and pipe lines already in use in connection with existing supplies, as well as those proposed by Mr. Hazen for conveying water from the proposed Long Hill storage system to the present 33 water-works systems in the New Jersey Metropolitan District.

Passaic Great Reservoir—A dam 7,700 ft. long at the flow line, built across the Passaic River above Little Falls would store 290 billion gallons of water, of which 220 would be available above the proposed low water flow line of 180 ft. above tidewater, the available draft of water being only 20 ft. This reservoir would afford an equalized yield of 757 m.g.d., of which 80 m.g.d. would be allowed to flow down the stream for industrial purposes and river sanitation, leaving 667 m.g.d. available for public water supply. In addition, the Passaic Great Reservoir would prevent floods on the lower Passaic, one of which in 1903 caused immense damage and led to the recommendation of a reservoir on this very same site for flood control, but with a lower flow line than is now proposed. This reservoir would also flood large areas of meadow which now create a great nuisance through mosquito breeding.

Two drawbacks to the Passaic Great Reservoir are the necessity of providing the entire storage at once, involving high unit cost while the consumption is relatively low, and also the number of buildings existing on portions of the 61.5 miles that would be covered by the reservoir. Dwellings of all kinds that would be flooded total 2,150, but many of these are below the level of the 1903 flood. The reservoir would also flood four water-works plants, including the stations for pumping from wells for the supply of East Orange and the Commonwealth Water Co. The water power at Pompton Lake would be submerged and also the Du Pont powder works at Wayne. It is estimated that the buildings and industries that would be submerged by the Passaic Great Reservoir are equivalent to what would be "found in an average city of 10,000 or 12,000 inhabitants." Both the Delaware, Lackawanna & Western R.R. and the Greenwood Lake Division of the Erie R.R. cross the reservoir, besides many important highways, all of which would require more or less relocation. It would also be necessary to build a trunk sewer to divert the sewage of several small towns to a point below Little Falls.

It may be noted in passing that if the Passaic Great Reservoir were not built there would still be made available by existing and proposed storage on some of the Passaic tributaries a considerable total volume of water which in no way would affect the yield from what may be termed the rival Passaic storage system (Long Hill) to be described next. It may also be noted that if the Passaic Great Reservoir were not built and the Long Hill reservoir was constructed, then the storage now being developed on the Wanaque could be sent down the stream beds of the Wanaque, Pompton and Passaic Rivers and be utilized by means of the pumping and filter plant at Little Falls.

Long Hill Reservoir—Alternative to the Passaic Great Falls Reservoir is the Long Hill Reservoir, supplemented by northern streams, and eventually by pumping from the Delaware River if found desirable. The Long Hill reservoir would be formed by a dam near Millington, on trap rock, 110 ft. high and 850 ft. long at the flow line, compared with the dam 7,700 ft. long to form the Passaic Great Reservoir. The Long Hill reservoir would have an area of 24 sq.mi., compared with the 61.5 sq.mi. of the Passaic Great Reservoir, but owing to its greater depth (see Table I) the Long Hill reservoir would store 328 billion gallons to the bottom, of which 182 would be available at the proposed low water flow line of 280 ft. above tide level, or a full 100 ft. higher than the low water flow line of the Passaic Great Reservoir at Little Falls. The elevation and capacities of the various reservoirs supplementary to the Long Hill are shown in Table I in the line above the figures there given for the Long Hill reservoir. The safe yield from the Long Hill reservoir system is placed at 619 m.g.d.—without any pumping from the Delaware River. This amount plus what can be obtained from the Passaic and its tributaries entirely below this reservoir and from various other sources available, would be more than is needed to supply the New Jersey Metropolitan District for fifty years to come.

Water-supply rights of the Morris Canal in Lake Hopatcong, in Greenwood Lake, and other bodies of water in the Passaic catchment area would not be interfered with under the development scheme proposed by Mr. Hazen. Should this canal be abandoned [as has been proposed for years past is provided for in a bill that passed the New Jersey Legislature last week] and these rights become available for municipal water supply there would be some addition to the yield from the Passaic projects.

In making estimates for the yields of the various catchment areas considered, Mr. Hazen allowed a correction factor not only for the percentage of water surface in each area but also for the average elevation of these areas. Allowances were also made for the amounts of "ground storage yield" to the reservoir, ranging from 60 days to nothing in terms of net yield. [See Mr.

Hazen's paper, Trans. Am. Soc. C. E., vol. 77, p. 1539, or "American Civil Engineer's Pocket Book for Definition of 'Ground Storage Yield.' "]

Population on Catchment Areas—On the Long Hill catchment area of 645.5 sq.mi., including that of the supplementary reservoirs, the total population in 1920 was 39,544, or 61 per square mile. In 1910 the population per square mile was 67 and in 1900 it was 61, or the same as in 1920. On the Passaic Great Reservoir catchment area of 761.2 sq.mi. above Little Falls the total population in 1920 was 116,303, or 153 per square mile. In 1910 the population per square mile above Little Falls was 133 and in 1900 it was 114. The proposal to divert sewage of certain towns below the Little Falls dam has already been mentioned. The Raritan catchment area had a population of about 70 per square mile in 1920, which was about the same as in both 1910 and 1900. The Mullica and Wading River combined catchment areas had a population of only 29 per square mile in 1920.

The catchment area of the existing Pequannock supply for the city of Newark had a population of only 16 per square mile in 1920 compared with 17 in 1910 and 18 in 1900. [The city of Newark has been gradually acquiring this catchment area until it now owns a very large percentage of it.] In the Rockaway catchment area of the Jersey City water supply the population per square mile was 210 in 1920, 179 in 1910, and 190 in 1900. The Wanaque catchment area above the dam now being built for Newark had a population per sq.mi. of 25 in 1920, 20 in 1910, and 16 in 1900. The existing Hackensack River catchment area had a population of 325 per sq.mi. in 1920, compared with 260 in 1910 and 156 in 1900.

The total number of dwelling houses that would be submerged not only by the Long Hill reservoir but also by all of the reservoirs tributary to it is 781. Comparatively few industries would be submerged. The houses and industries that would be flooded, Mr. Hazen states, would correspond roughly to a community of 4,000 population. Sewage from the portion of Morristown that would naturally drain into this reservoir basin is already diverted outside the catchment area.

Water Distribution—The Long Hill reservoir system would give "gravity service to much the largest part of the district," but areas above El.200 in Montclair, the Oranges, and elsewhere would be in high service pumping districts (see shaded areas on Fig. 4). The water from the Long Hill as well as from the Passaic Great and other proposed reservoirs would be filtered. At the Long Hill reservoir it is proposed to put the filters at such an elevation that they would deliver water to the pressure tunnel mentioned further on at a head of 280 ft. above tidewater. The upper 20 to 30 ft. of the total 40 ft. storage which it is assumed would be utilized from the Long Hill reservoir would flow to these filters by gravity. The water in these upper levels would be sufficient for many years to come. When it was necessary to install booster pumps, they would take water out from below the 280-ft. flow-line elevation.

A pressure tunnel only 19 miles long would convey water from the Long Hill reservoir to Jersey City, passing beneath Newark and connecting with the distribution system of that city en route and connecting at Jersey City with supply mains running south to Bayonne and north to the Hackensack water system at Hoboken. The southern loop pipe line would extend from the tunnel in Newark to Elizabeth and Rahway. This could be extended, if desired, "all the way around through Plainfield, as a belt line, and give an independent connection with the Long Hill reservoir," serving a region where large additional quantities of water are likely to be required.

The present Pequannock supply owned and used by Newark is "available by gravity at a higher elevation than any other part of the proposed supply." Mr. Hazen suggests that by pooling all the sources of supply "it would be good business to use Pequannock water for the high service only, thus avoiding pumping." The Jersey City reservoir at Boonton on the Rockaway and the proposed Wanaque reservoirs "are slightly lower than the proposed Long Hill reservoir, but the differences are not enough to be troublesome," since booster pumps could be used "on any of the supply lines where the head was otherwise deficient." Water from the Little Falls plant would go to the same distribution system by pumping. Most of the water supplied to this district, Mr. Hazen states, now passes through Great Notch at "a point about four miles south of Paterson which might be well called 'Grand Junction,' for so many of the present main supply lines pass through it."

If the Passaic Great Reservoir instead of the Long Hill reservoir were the main source of supply, additional filters and pumping plant could be built at Little Falls; or a tunnel could be driven "from the reservoir to some convenient point of distribution on the eastern slope where filters and pumping stations could be located." Mr. Hazen adds that "such a tunnel might take the water from the southern end of the reservoir."

Dual System of Water Supply—In view of the large volumes of water used for industrial purposes in the New Jersey Metropolitan District, Mr. Hazen asks: "Why not have two grades of water like two grades of milk? Grade A water to be used for the primary systems for all domestic purposes, and Grade B water to be used for industrial purposes." The Grade B water could be chlorinated so heavily that "there would be little valid ground for objection to it for sanitary reasons." The Grade B water could also be "supplied at lower pressure and at a lower price" than the Grade A water, thus aiding industry and affording "a market for waters that are not suitable for domestic requirements."

Costs—Comparative costs for the four projects are given in some detail in Table II while Table III gives costs of successive stages of the Long Hill Reservoir scheme, with pumping from the Delaware River.

Suggested Program—The engineering problem of providing water for the New Jersey metropolitan district can be readily handled, Mr. Hazen says, and the financial problems are also easy of solution by means of a proper system of charging for the water delivered wholesale to the different communities and companies. The real problem lies in the "diversity of ownership in 33 separate systems of water supply now in the district," which Mr. Hazen says, makes it "almost impossible to hope for an adequate solution by voluntary co-operation." In view of this and also the fact that the necessary operations will extend through a long term of years and that action must be taken and money spent long in advance of the need for some of the sources of water supply that will be required eventually, Mr. Hazen suggests the creation of a water board with power to acquire existing and additional sources of supply, and to

build water-supply works, to sell water at wholesale and to issue bonds to pay for the works. A board of three members would be large enough. These should be men who can handle "large enterprises efficiently and economically" and who would be "in a position to decide all questions on their merits and without political or other obligations to anyone."

Such a board once created would immediately "take over some of the larger supply works [but not the distribution systems] now in service," including perhaps those of Newark, Jersey City, the East Jersey Water Co., including in the latter the present Little Falls pumping and filtration plant. The board would also take the dam now being built at Newark on the Wanaque by the North Jersey District Water Supply Commission. When this dam is completed to its full height, water from it could be delivered down existing streams and taken out at the Little Falls plant, which would then have to be enlarged.

Acknowledgment of co-operation is given by Mr. Hazen to the Department of Conservation and Development of New Jersey, with special mention of Alfred Gaskill, director, Dr. Henry B. Kummel, geologist, and H. T. Critchlow, hydraulic engineer. Co-operation was also given by engineers and others connected with many of the 33 water-works systems now operating in the New Jersey Metropolitan District. Much time was devoted to the collection of field data and various studies by Malcolm Pirnie of the staff of Hazen, Fuller & Whipple.

Engineering as a Human Activity

Extracts from a paper by Prof. H. E. Riggs, of the University of Michigan, before the Michigan Engineering Society, on some of the non-technical sides of engineering. Jobs and how to get them; fees and how to maintain them; scalawags and how to treat them are always interesting topics.—EDITOR.

AS I look back over a professional practice of more than 30 years, I am impressed by a few facts which you older men can verify and you younger ones must never forget. The friendships formed during those years are very largely among engineers, not mere acquaintances, but the warmest of close personal friendships. The large majority of the work that has come to me and by far the largest part of my total income, has come directly or indirectly through other engineers. These two facts lead me to say to you that we cannot get along without one another, that our profession is so big and covers such an infinite multitude of specialized lines of work that no one man can possibly fit himself for more than a limited service and that he is constantly coming into contact with problems that demand the attention of other engineers than himself.

The man who takes this view, who sees that he can afford to be helpful and not selfish, who realizes that on a big job there is credit enough for all, and who says "we did a big piece of work and if it had not been for the splendid work of these other men it would not have been possible," is the really big man and soon or late the world will see his bigness.

Twenty or more years ago John W. Alvord read a paper before the Illinois Engineering Society entitled "The Theory and Practice of Getting a Job." Hunt it up and read it. It entitles Mr. Alvord to a place among the great American humorists. It also proves him a philosopher.

As I recall it, he states the theory as the beautiful dream of the day when gray-haired corporation presidents will wait in your outer office until it is your pleasure to see them and will then beg you to accept the commission of designing their work and spending their millions.

The practice is a different matter. You hear of a job of designing a pavement in the next county seat and you hie you there by the first train. You find that you are fourth or fifth man, and that a prominent engineer from Chicago, of national reputation, happened to be passing through and dropped off for a chat with his college classmate, the banker, and, hearing of the job, agreed to take it for the banker's sake.

The question is what to do? You want a job. You need one for the money there is in it. Will you knock him, cut prices, use improper influence, get sore, or will you do your best to put the competition on a high plane by putting your price up where it belongs and letting the other fellow take the work at a losing figure if he wants to?

My own observation is that the world is full of jobs, and if you will devote yourself to doing your job, when you get it, a little better than anyone else ever did an engineering job in that town, if you will watch the trouble on the job and see to it that no criticism is made that is not followed to the end, you will make friends on the job who will land the next one for you.

It is absolutely impossible to please everybody. Don't try. Do the job in such a way that you are sure you are right, have reasons for all you do, use the best diplomacy of which you are capable in satisfying the owner that you are right. Be honest, be fearless and you will find job after job coming to you. Use your friends. If you are worth while it will be a pleasure to them to help you.

Don't cut prices. If you have been working for $200 per month for some other fellow and have gone in for yourself, on your first job, don't ask $100 per day. Take $15 or $20. The expert fees will come with the gray hair and the experience.

It has always seemed better to me to let the other fellow, who insists on taking work at less than cost, get the job. Remember that while he has it, he will not be after another, and your chances of getting the new one at a right price is so much the better.

Some of us lack diplomacy. We may be good engineers but our psychology is poor. We cannot convince the man with the money that we do know enough to take charge of his work. If after several experiences we find this to be the fact, we had best work for some fellow who has the God-given gift of convincing the world that he can be trusted to do anything.

I would say to you young men, with all the earnestness there is in me, stick together, work together. What benefits one benefits all. Engineering is an infinitely better profession than when Frank Rogers, Clarence Hubbell and myself were in your places. Make the same kind of friendships that we made. Keep sweet. Do the things that you know are right and honest. The big thing is that the field of engineering does have rich rewards for the man who loves it, and who does his work as the work which the Master sent him to do in making the world a better place.

If you are going to be happy in your work, avoid small town gossip. Fight in the open if you have to fight. If gossip is right, and your friend is no longer your friend, better know it and govern yourself accordingly.

There are now, always have been and always will be, men in every profession who do not belong there. Some are untrained and ignorant. They have acquired a certain amount of practical skill in some branch of work and have undertaken to claim membership in the profession. Some are dishonest and a disgrace to the profession. You ask what shall we do with these? Be sure their ways will find them out. When it becomes clear where they belong, when no doubt remains, then the profession should be purged of these men. A few years ago Prof. J. B. Davis, one of the founders of this society and one of the greatest teachers and greatest men in the profession, said in a discussion of this subject: "When a man comes across a rattlesnake in the path it is his duty to kill it."

The new registration law is bound to help conditions and the fact that many states have adopted such laws will tend to place engineering upon a higher plane, but after all the laws are in full operation, we will still need to drop back upon ethics, we will still have to use the Golden Rule, we will still have to watch ourselves and we will still have to kill rattlesnakes.

Thin Concrete Lining Successful In Irrigation Canals

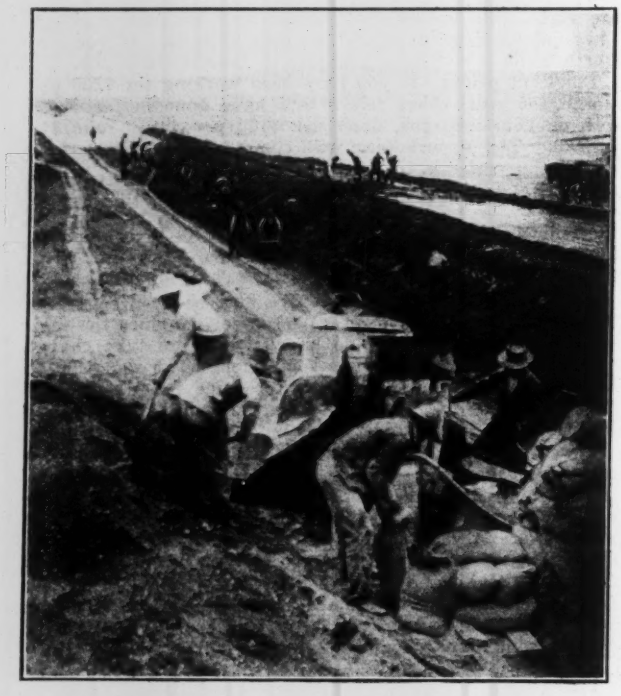
On 64 Miles of Canal Saves in Maintenance and Permits Less Seepage Than Earth Construction

By R. C. E. Weber

Project Manager, U. S. Reclamation Service, Orland, Cal.

CANAL lining, 1½ in. thick, placed on 64 miles of the main distribution system of the Orland Project of the U. S. Reclamation Service, at a cost of 39c. per square yard has effected a saving of 60 per cent in maintenance costs over earth sections and has reduced seepage losses to less than one-third of those in clay.

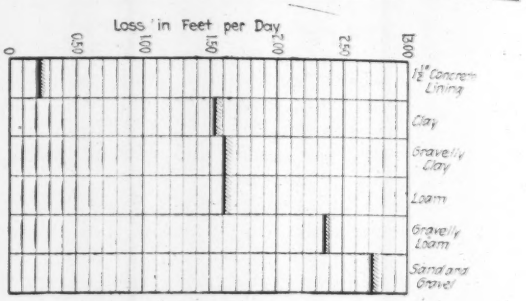
The first concrete lining was placed during the fall of 1911 following the first season of operation. The work performed at that time consisted of lining several high fills in the High Line canal together with laterals



DISTRIBUTION OF LABOR IN LINING CREW

located in a rich, loam soil, in which vegetation grew so luxuriantly as to require cleaning several times during the operating season. The results of the first lining placed were so satisfactory that the work has been carried on each year until at the present time 64 of the total 146 miles of the project distributary channels are lined with concrete. The original plan of the project contemplated and provided for about 30 miles of lined canals and laterals, but the increasing cost of maintenance from year to year together with the heavy distribution losses made necessary the adoption of a more comprehensive plan for concrete lining. Accordingly, in 1917 the project land owners entered into a supplemental agreement with the Secretary of the Interior whereby the land owners acquiesced to an estimated increased cost of $220,000 for lining approximately 70 miles of canals and laterals.

Comparative costs for maintaining concrete-lined



SEEPAGE AND EVAPORATION LOSSES FROM CANALS

channels and earth sections have been kept with the following result: The average cost per mile for concrete-lined section was found to be $19.50. It was $53.70 per mile for earth section. A saving of $34.20 per mile, or 64 per cent, therefore is effected in maintenance costs by the use of lining. In addition to this marked reduction in maintenance cost, there is the reduction of distribution losses and the increased operating safety.

Seepage and evaporation losses in concrete-lined sections and in earth sections of various general soil types are available covering the series of irrigating seasons extending from 1911 to 1920. These losses are in terms of depth in feet per 24 hours over wetted perimeter and are graphically represented by the accompanying diagram. The maximum loss of 2.79 ft. occurs in the sand and gravelly earth section, which by means of concrete lining may be reduced to a loss as low as 0.28 ft.

On account of the fact that the major portion of the project is under irrigation it is not practicable to carry on extensive lining operations during the irrigation season, and the time for lining is necessarily confined to a period of six months, extending from Oct. 1 to April 1.

Approximately 75 per cent of the lining placed on the project has been machine mixed, the remainder having been mixed by hand. Because of the frequent moves in connection with the lining of laterals, mixers of from 3- to 4-cu.ft. capacity are best adapted to the work. Line and grade stakes for bottom of floor and top of lining are provided at intervals of 15 ft. The section is prepared for lining by means of mattocks, picks and square-point shovels, a force of 15 to 25 men (depending on the nature and hardness of the soil encountered) being necessary to keep in advance of the concrete force. The concrete force consists of three men charging hopper with gravel, cement and water, one mixer operator, one man at the chute conveying concrete from the mixer on the bank to the wheelbarrows in the canal, three to seven wheelers (depending on the distance) transporting concrete in end-dump wheelbarrows from the chute to placers, two men placing concrete on slopes and floor and two men finishing. To eliminate wheeling the concrete into the canal section, a metal-lined chute is provided to convey the concrete from the discharge spout of the mixer to wheelbarrows placed directly in the canal section. The maximum length of wheelbarrow haul is 300 ft., mixer set-ups being at 600 ft. intervals. Slopes when dry are thoroughly sprinkled in advance of the concrete and the lining is kept wet for three days following placing. The usual practice is to work downstream, bringing water, controlled by small earth dams, down over the lining the day following placing.

In order to place the lining on the side slopes it is necessary to use a comparatively dry mix of concrete. The same consistency is used for the floor, as it is difficult to transport a wet mixture in wheelbarrows. Water as required is sprinkled over the floor after the concrete is spread, just ahead of the finishing operation. Finishing on the side slopes is first accomplished roughly by means of the reverse side of a square-point shovel and the final operation with a finishing trowel: On the floor shovels are also used but most of the finishing is done by means of a special trowel of heavier construction than that used on the side slopes.

Expansion joints, provided on the side slopes only, at intervals of 6 ft., are made as follows: After the surface has been given a final finishing, the concrete is cut through by means of a pointing trowel guided by a straight edge and the joint thus made is smoothed by a sidewalk jointer. The mixture of concrete used for lining is 1:7 and the average thickness of the lining is 1½ in. Lining of this thickness placed in 1911 and in use since that date is in excellent condition, demonstrating the durability of this thickness of lining in this locality where mild winters prevail with a minimum temperature of 25 deg. F. above zero. Run-of-bank gravel from local creeks is used for aggregate. Gravel with rock not exceeding 1 in. in size is found in its natural state which requires neither washing nor screening for a satisfactory quality of concrete.

COMPLETED LINING ON 225-SEC.-FT. CANAL

Costs.—Since 1911 there has been placed a total of 622,000 sq.yd. of 1½-in. lining on the Orland Project at an average cost of 39.1c. per square yard. This cost was incurred over a period when wages for ordinary labor varied from a minimum of $2.40 to a maximum of $4 per day, and when other items of cost varied in about the same proportion. For the purpose of giving a detail of the various items entering into the cost and also to indicate how costs are returning to normal the following tabular analysis is given of cost per square yard of lining placed during the year 1920 and during the fall construction period of 1921:

Items	Cost for Year 1920	Oct., Nov. & Dec. 1921
Preparing slopes and bottom	$0.091	$0.057
Cement	0.135	0.103
Gravel	0.054	0.059
Mixing	0.035	0.018
Placing	0.053	0.036
Finishing	0.010	0.003
Sprinkling and protecting	0.003	0.001
Water	0.007	0.004
Repairs and supplies	0.005	0.006
Equipment charge	0.003	0.005
Total labor and material cost	$0.396	$0.292
Superintendence	$0.018	$0.015
Engineering	0.006	0.002
General expense	0.035	0.056
Total overhead	$0.059	$0.073
Total cost per square yard	$0.455	$0.365

The average labor costs per day for the year 1920 were as follows: Laborers, $4 and $4.24; placers, $5; finishers, $6; teamsters with two horses, $7; and teamsters with four horses, $10.25. The average haul for gravel was 3 miles and for cement 4 miles. The cost of cement at the project warehouse was $3.20 per barrel. The 116,599 sq.yd. lining was placed on 10.75 miles of canals and laterals. The capacity of the sections lined varied from 15 to 225 sec.-ft. The bottom widths were from 3 to 14 ft., vertical height from 2 to 4.5 ft. and side slopes 1½ to 1 and 2 to 1. For the fall period of 1921 the following prices prevailed: Laborers, $3 and $3.25; placers, $4; teamsters with two horses, $5.50; teamsters with four horses, $8 and finishers, $4.25. The average haul for gravel was 4 miles and for cement 3 miles. Cement at the project warehouse cost $2.90 per barrel. Five and four-tenths miles of laterals with capacities varying from 15 to 35 sec.-ft. were lined, on which 45,618 sq.yd. of lining were placed. The sections lined varied from 3 to 5 ft. in bottom width, 1.5 to 3.5 ft. in vertical height and had side slopes of 1½ to 1.

Most of the concrete lining was placed when A. N. Burch was project manager and the writer, engineer in charge of construction. All of it has been carried out by day labor under the direction of Reclamation Service engineers.

Water From Missouri River Advised To Increase St. Louis Supply

A PROJECT for an additional water supply for St. Louis, Mo., to be drawn from the Missouri River at a point eight miles above St. Charles, Mo., was outlined by Edward E. Wall, water commissioner of St. Louis, in a paper read before the Associated Engineering Societies of that city on Feb. 1. The project includes a shore intake, low- and high-service pumps, a purification plant, distribution reservoir and supply mains leading from the reservoir to the southern and western parts of the city, leaving the northern part to be served from the present Mississippi plant at the Chain of Rocks. The cost of the new works, sufficient, with the proposed enlargements to the existing works, to supply the city and outlying territory until 1960 is placed at $22,000,000, but for the immediate future an outlay of only $12,000,000 is proposed. Ordinances for the acquirement of land at the new site and for a $12,000,000 bond election have been drawn by Mr. Wall. The proposed date of the election is Aug. 1.

In contrast with the Chain of Rocks intake, which for local reasons is about a half mile from shore, in rather shallow water, and gives rise to ice and other troubles, the new intake at Howard Point would be on the convex side of a long curve, where the river hugs the shore. Dikes have been planned which would make the river scour out and maintain a deep channel.

It is estimated that by 1926 the new plant would be delivering an average of about 30 m.g.d. Additions would be made as needed until in 1942 the new works would be supplying 80 to 90 m.g.d. and in 1960 an average of 120 m.g.d., giving a total average daily supply from this plant and the present one at Chain of Rocks of 240 m.g.d., or water for the 1,500,000 estimated population of St. Louis County at that time.

The $12,000,000 estimated cost of the plant built up to 1942 is distributed as follows: Land, dikes and bank protection, intake, buildings, purification works and accessories, $3,711,000; three 50-m.g.d. low-service and four 30-m.g.d. high service pumps and boiler plant, $1,417,000; 72-in. steel main, $1,589,000; 100 m.g.d. reservoir, $1,130,000 pipe lines connecting with distribution system, $3,133,000; 10 per cent for contingencies, $1,100,000; total, $12,110,000.

Wind Pressures at High Elevations and Their Application to Radio Towers

A Review of Practice and Theory—Observations Showing That Wind Velocity Increases with Height —More Experiments Needed—The Gradient Wind—Recommended Loads and Stresses for Design of High Towers

By R. Fleming
American Bridge Co., New York

It has long been known that wind velocity, and consequently wind pressure, increases with the height above ground. Yet it is customary to design steel frames of buildings for uniform wind pressure throughout. The paragraphs in the New York building code calling for a wind load of 30 lb. per sq.ft. and in the Chicago code of 20 lb. are intended for wind loads at all elevations. While this is not logical, the errors in building design that may result are not serious. High buildings in cities are somewhat sheltered by surrounding buildings and the lower portions may be subjected to little or no wind load. Moreover, the wind load is not the dominant load, but its effect on the members of the structure is usually exceeded by that of the vertical loads.

Building Codes that Consider Height

While most building codes call for uniform wind pressure regardless of height, there are exceptions. In London, where the skyscraper is unknown, buildings are designed to resist a horizontal pressure of not less than 30 lb. per sq.ft. on the upper two-thirds of the surface exposed to the wind. In Philadelphia, for high buildings erected in built-up districts, wind pressure is figured at not less than 25 lb. per sq.ft. at the tenth story, 2½ lb. less on each succeeding lower story, and 2½ lb. additional on each succeeding upper story to a maximum of 35 lb. at the fourteenth story and above. In Boston, where buildings are restricted to heights not exceeding 125 ft., the revised code (1919) calls for a wind pressure of 10 lb. per sq.ft. for vertical surfaces 40 ft. in height, 15 lb. for portions from 40 to 80 ft., and 20 lb. for portions more than 80 ft. above the ground.

Prof. Henry Adams in his book, "The Mechanics of Building Construction," London, 1912, under "Finding Stresses in Roof Trusses," writes, "The author's formula for wind pressure gives a value increasing with the height of the ground and decreasing with the width to be taken. It is: $\log p = 1.125 + 0.32\ h - 0.12 \log w$ where p = ultimate wind pressure in lb. per sq.ft. necessary to be allowed for against a plane surface normal to the wind, h = height of center of gravity of surface considered above the ground level in feet, w = width in feet of part taken as one surface." The same formula is given in a previous book by Adams, "Theory and Practice of Designing," under "Steel-Framed Sheds."

Evidently Adams had mainly in mind roofs and roof trusses. If his formula is applied to the side surfaces of buildings the value of h in the formula is one-half the height of the building. If the wind pressure on the sides is carried to the ends by horizontal bracing w is increased and p is thereby reduced. The limitations of the Adams formula may be inferred from the following values: For $h = 50$ and $w = 20$, $p = 32.6$; $h = 50$ and $w = 100$, $p = 26.8$; $h = 100$ and $w = 20$, $p = 40.6$; $h = 100$ and $w = 100$, $p = 33.5$; $h = 100$ and $w = 200$, $p = 30.8$.

Eiffel Tower—In tower design the wind is a far more important factor than in the design of buildings. What wind load shall be assumed, is one of the first questions asked regarding a proposed tower. In the design of that king of towers, the 1,000-ft. Eiffel Tower of Paris, two assumptions were made: A horizontal wind pressure of 300 kg. per square meter (61.4 lb. per sq.ft.) of surface, and a pressure varying from 200 kg. at the base to 400 kg. per square meter (40.9 to 81.9 lb. per sq.ft.) at the top. The committee appointed to examine the design, in its report approving the project, said: "These limits are notably more than the pressures of winds observed in our climate." It is related of Eiffel that when asked what would happen if his proposed tower should topple over he replied that it was calculated to withstand a pressure of 61.4 lb. per sq.ft. counting the lattice work as full surface, and that in such a wind little would be left standing except the tower.

U. S. Navy Practice—With wireless towers the cost is materially affected by the wind loading assumed. In towers of the U. S. Navy type a wind pressure of 30 lb. per sq.ft. of vertical surface has been commonly (though not always) assumed. This loading was used in designing the triangular towers of the San Diego, Pearl Harbor, Cavite and other high-powered stations. Several of these towers are 600 ft. high.

It may be stated here that "Wind, 30 pounds per square foot," as inscribed on the name plate of the Guam towers, does not furnish complete information. In a self-supporting tower have the members on the leeward side been considered protected to any extent by those on the windward side? In proportioning the several parts has the surface-area of one side, of two sides or some intermediate value been assumed as exposed to the wind?

Specifications for Monroe Towers

The specifications (1918) of the U. S. Navy Department for 20 radial brick towers, each 500 ft. high, at Monroe, N. C., called for a wind pressure on the vertical projection of 40 lb. per sq.ft. for the first 100 ft. from the top, 35 lb. for the next 100 ft., etc., and 20 lb. for the lower 100 ft. Further, a pressure of 40 lb. was to be considered acting on the spreader trusses. Specifications for alternate 820-ft. triangular steel towers called for a wind pressure of 30 lb. per sq.ft. on 1½ times the exposed area of one face.

Radio Corporations—The "Radio Central" Station at Port Jefferson, L. I., when fully completed with its 72 towers will be the largest and most powerful radio station in the world. The twelve 400-ft. square towers now in use were designed for a wind pressure of 30 lb. per sq.ft. of vertical surface acting on twice the projected area of one face for the upper 300 ft. and on 1½ times the projected area of one face for the lower part.

The specifications (1919) of the Marconi Wireless Telegraph Co., Ltd., (London) for towers 800 ft. nigh require the design to provide for, "a wind pressure of 30 lb. per sq.ft. over the whole of the exposed surface in the direction of the wind on the front framing and 30 lb. ditto on the back framing."

The wooden lattice masts, 714 ft. high, of the radio station of the Italian navy at Rome (San Palo) built in 1917 during the stress of war, were designed for a wind pressure of 61.5 lb. per sq.ft. (C. F. Elwell, *Proceedings of the Institute of Radio Engineers*, June, 1920, p. 194.)

The great French station at Croix d'Hins, 14 miles southwest of Bordeaux, known as the "Lafayette Radio Station," was designed to meet the exigencies of war. Happily the armistice came and the station was finished in times of peace. The eight triangular steel towers, 820 ft. high, fabricated by the Pittsburgh-Des Moines Steel Co., of Pittsburgh, were designed by the Bureau of Yards and Docks of the U. S. Navy. Wind pressure was assumed at 30 lb. per sq.ft. on an area 1½ times the exposed surface of one face. (Lieut. Copeland, *United States Naval Institute Proceedings*, Dec. 1920, p. 1905.)

The circular concrete wireless tower at Tokyo is the tallest masonry structure on record, being 660 ft. high above ground level. "The wind pressure on a plane area was taken at 60 lb. per sq.ft. at the ground level and 126 lb. per sq.ft. at the top, changing uniformly between these two extremes, while the coefficient of reduction for the projected area was taken at two-thirds." (Prof. Shibata, *Engineering News-Record*, Aug. 4, 1921, p. 204.)

Wind Loading Data not Always Given

It is to be regretted that the *Zeitschrift des Vereins deutscher Ingenieure* (Nov. 20 and 27, 1920), in its 24 columns on the great German station at Nauen, does not give complete information regarding the wind loading assumed in the design of the 260-meter (853-ft.) masts. It is stated that 350 kg. per square meter (71.7 lb. per sq.ft.) perpendicular to the vertical surface was used at the summit, but nothing is said about loading at the base. A lack of information about wind loading is quite common in descriptive articles, even in those in technical papers. *Le Genie Civil*, Dec. 11, 1920, in a 10-page article on the Lafayette station says nothing about wind. *Engineering*, May 3, 1889, devotes 8 of its large pages to the Eiffel tower, but the reader must look elsewhere for information on the important matter of wind loading assumed in the design.

Activity in Wireless—We seem to be on the eve of worldwide wireless. In current electrical papers may be found items, as "Belgium is to begin the building of a wireless station, having eight steel antenna towers, each 850 ft. high"; "A new high power station at St. Assise, France, will be one of the most powerful in the world. It is intended to erect sixteen towers somewhat higher than those of the American-built station at Bordeaux." "The report of the Imperial Wireless Committee recommends the construction of a chain of wireless stations about 2,000 miles apart"; "Brazil plans Radio Expansion." The 1,000-ft. tower is a possibility.

The choice between increased cost of power with lower towers and increased cost of higher towers with lessened cost of power is made by the radio engineer. For his benefit it may be said that the weight of steel in self-supporting steel towers varies nearly as the square of the height. For instance, if the 400 ft. towers of the Radio Central requiring 130 tons of steel each had been built 800 ft. high the weight of steel would have been about 450 tons each.

From the variations of wind loading cited it may be inferred that the assumption of wind pressure on high towers has been largely a matter of guess. As far as known, no disastrous failures have occurred from past assumptions, but the time has come when the relation of wind pressure to height should be more accurately determined. Different formulas have been advanced, but they are based on rather narrow ranges of experiments and are thus limited in application to structural design.

Variation of Pressure With Height—Thomas Stevenson, in "Report on Simultaneous Observations of the Force of Wind at Different Heights above the Ground" (*Journal of the Scottish Meteorological Society*, March, 1880, p. 348) from a series of observations on winds varying from 2 to 44 m.p.h. concludes that for *small heights* the velocity V at any point H above the ground, from the known velocity v at a height h (h being above 15 ft.) may be expressed by the formula

$$V = v\sqrt{\frac{H + 72}{h + 72}}$$

His observations were made at stations 276 ft. to 1617 ft. above sea level and did not include heights more than 50 ft. above the ground. Later, in writing on the same subject (*Proceedings of the Institution of Civil Engineers*, Vol. 69, 1882, p. 120) he thinks the formula "should be applicable to lofty engineering structures such as lighthouse towers, chimneys, and high-level bridges." Since wind pressure varies as the square of the velocity $P/p = V^2/v^2$, or by the Stevenson formula,

$$P = p\,\frac{H + 72}{h + 72}$$

where P and p represent pressures per sq.ft. at H and h respectively. It is seen at a glance that this formula does not apply to high towers. For if $p = 25$ and $h = 50$, P is equal to 178.7 when $H = 800$, and 219.6 when $H = 1{,}000$. Stevenson also writes, "when it is wanted to ascertain the velocity for *great heights* above the sea level, the approximately correct formula, which is believed to be sufficiently correct for practical purposes, is $V = v\,\frac{H}{h}$." Evidently H and h are elevations above the sea level. This formula in terms of pressure becomes $P = p\,\frac{h^2}{H^2}$.

Archibald's Exponential Formula—E. Douglas Archibald presented a paper, "On some Results of Observations with Kite-wire-suspended Anemometers up to 1,300 ft. above Ground, or 1,800 ft. above Sea Level, in 1883-5," at the Aberdeen meeting (1885) of the British Association for the Advancement of Science. The paper is an enlargement of one he presented at the Montreal meeting the previous year. It is published more fully in *Nature* (Vol. 33, Apr. 22, 1886, p. 593) than in the Association Reports. Prof. Archibald endeavored to determine values for the exponent x in the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^x$.

where V, v, H and h are the velocities recorded by and

heights of the instruments. He divided his 42 observations into 6 groups and made the following table:

TABLE I. OBSERVATIONS BY ARCHIBALD

Group	Number of observations	Mean height of upper instrument above ground, ft.	Mean height of lower instrument, ft.	Mean height of both	Mean velocity at both heights, ft. per min.	Mean Upper and Lower Velocities ft. per min. Upper	Lower	Mean value of x
1	7	250	102	176	1,395	1,617	1,174	0.372
2	3	322	128	225	1,955	2,232	1,679	0.307
3	8	407	179	293	1,545	1,705	1,385	0.275
4	5	549	252	400	1,940	2,107	1,773	0.237
5	9	795	481	638	2,074	2,192	1,957	0.250
6	10	1,095	767	931	2,166	2,236	2,096	0.194

The conclusion the author draws from his table is that the velocity of the wind *always* increases from the surface of the ground up to 1,800 ft. above sea level, and that the ratio of the increase steadily diminishes up to that height. "The only exception to the steady decrease in the value of x occurs in Group 5, and this is evidently due to the inclusion in that group of an abnormally large value of x (0.576), corresponding to an abnormally small velocity of 789 ft. per min., which is little more than a third of the mean velocity of the stratum corresponding to that group." The author is to be commended for including in his table *all* observations. Investigators have sometimes thrown out those that did not conform to a proposed equation or theory.

Other Observations—Dr. W. N. Shaw, later Sir Napier Shaw, published in 1909 ("Report of the Advisory Committee for Aëronautics for the year 1909-10") his formula, $V = \frac{H + a}{a} v$,

in which V is the supposed velocity at height H above ground; v the anemometer velocity at the ground, and a is the height above sea level. The formula is supposed to apply until the "gradient velocity" is reached. It was tried by Shaw as far as proportionality to height is concerned for places at altitudes of 377 ft., 492 ft., 541 ft., and 1,100 ft. above sea level, and he writes, "It seems likely to prove very effective." It is certainly not applicable to places near sea level, though Shaw writes, "At a well-exposed sea-coast station, a may be very small, so that the limiting or gradient velocity is soon reached."

W. H. Dines, who has given much study to the wind, says, "Judging from the result of 5 years' constant kite flying, it appeared that the velocity at 1,000 ft. elevation (at inland stations such as Bushy) was quite double that at the surface, but there was certainly no regular rule with which the increase occurred." (*Proceedings of the Institution of Civil Engineers*, Vol. 171, 1907-8, p. 215.)

The *Bulletin of the Mount Weather Observatory* (Vol. 2, June 1910, p. 357), quotes wind velocities taken at three observatories. At the top of the Eiffel Tower the average velocity for winter winds was 22 m.p.h., while at a distance about 68 ft. from the ground they averaged 5.4 miles. For the year they averaged 19.5 miles at the upper and 4.8 miles at the lower level. The records of the Prussian Aëronautical Observatory at Lindenburg (altitude of station above sea level, 122 meters = 400 ft.) show a velocity of 20.6 m.p.h. at an altitude above sea level of 500 meters (1,640 ft.) when the surface velocity was 11 miles. The velocities at 1,000 and 2,000 meters were 21.3 and 21.7 m.p.h. At the Blue Hill (Mass.) Observatory (altitude of station, 195 meters = 640 ft.) a velocity of 19.5 m.p.h. was recorded at an altitude of 500 meters when the surface velocity was 9.4 miles. At 1,000 meters altitude the velocity was 20.4, and at 1,500 meters altitude 23.7 m.p.h.

Wing's Conclusions—S. P. Wing (Civil Engineer, C. F. Elwell, Ltd.), in *The Electrician* (London), July 1, 1921, presents an article, "Wind Pressures and the Design of Radio and High Transmission Towers," which from the standpoint of the structural engineer is the most valuable presentation of the subject yet published. During 1915 he made observations at the wireless station at Ballybunion, Ireland, from anemometers placed on top of the 492-ft. mast, a 300-ft. mast, and points 40 and 15 ft. above the ground level. During the 40 observations the wind velocity varied from 0 to 37 m.p.h., and at different times came from nearly every point of the compass.

The general conclusions drawn by him are: (1) At a locality whose elevation is close to sea level the wind velocity increases considerably with increase in elevation above ground, and does not reach the limit of its increase at 500 ft.; (2) the increase is limited by the gradient wind and probably does not exceed by 15 per cent the increase reached at 500 ft.; (3) the extreme variation in wind velocity at 750 ft. is between 140 to 170 per cent of the ground velocity; and (4) an approximation to the actual pressures within a probable error of not more than 15 per cent is given by the equation

$$P = (0.00126\,h + 1.16)P_g$$

in which P = pressure in lb. per sq.ft. at point h ft. above ground, and P_g = pressure per sq.ft. at ground level. This equation is assumed to apply to high velocities (those of the order of 100 miles an hour) as well as those measured.

Mr. Wing places a modest value upon his experiments. "The results are too scattered," he says, "to prove anything definitely." Yet it is true, as he thinks, that the results "are useful in showing the limits of the increase in pressure with height and the need for allowing positively for this increase in the design of tall structures."

Table II shows values obtained for P in the Wing equation:

TABLE II

Wing Formula: $P=(0.00126h+1.16)\ P_g$

h	P	P (P_g=20)	P (P_g=25)
100	1.286 Pg.	25.72	32.15
200	1.412 Pg	28.24	35.30
300	1.538 Pg	30.76	38.45
400	1.664 Pg	33.28	41.60
500	1.790 Pg	35.80	44.75
600	1.916 Pg	38.32	47.90
700	2.042 Pg	40.84	51.05
800	2.168 Pg	43.36	54.20
900	2.294 Pg	45.88	57.35
1,000	2.420 Pg	48.40	60.50

Kempe, "The Engineers' Year Book," 1921, gives a formula for wind velocity based on the varying densities of the air as observed by a mercurial barometer. It is,

$$V = 1347.4\sqrt{\frac{H - h}{h}}\,(1 + 0.00208\,t)$$

where V = velocity in ft. per second, H and h = densities of the air in inches of mercury and t = temperature in degrees Fahrenheit.

Gradient Wind—The predictions of the Weather Bureau regarding the winds are made by mapping barometric heights observed simultaneously at different places after they have been reduced to what they presumably would have been if the stations were all at

a certain common level, that is, if all stations were at sea level. From the differences in pressure thus shown, the strength and course of the winds during the next 24 hours may be closely predicted. In meteorological circles winds are compared by their relation to the "gradient wind," which is "a theoretical wind based on the calculation of differences of pressure and is supposed to exist at some unknown distance above the earth's surface, where the effect of the earth's friction and local conditions are not felt. This wind is generally considered to be near the limiting velocity of all earth winds. This being the case, if, at a given place, we know the ratio which the ground winds bear to the gradient wind, then an estimate of the maximum gradient wind would give us an estimate of the maximum ground wind." (Wing.) Incidentally, the engineer could profitably acquaint himself with certain meteorological terms and methods. Humphrey's "Physics of the Air" will prove to be of great value in this direction. The four chapters "Atmospheric Circulation" are of unusual interest.

High Pressure Assumptions—It will be seen from the foregoing that data of wind pressure at high elevations are meager. Practically nothing is recorded regarding velocities a few hundred feet above ground level when a wind of 60 or 70 miles is blowing at the surface. An instance of present vagaries on the subject is shown by two sentences quoted from "Wireless Telegraphy," one of the D. U. Technical Series, bearing date 1921: "The stresses set up in the mast by the wind during storms are very considerable, and a large factor of safety must be allowed in their design. This is usually based upon a wind pressure of 500 kg. per square meter and a factor of three is allowed." Now, 500 kg. per square meter is equivalent to 102.4 lb. per sq.ft., an excessive pressure for wind.

Observed Velocity at 570-Ft. Level

Prof. Omori, in determining the oscillations of the 570-ft. Sagoneski chimney, encountered at the top a gale of 78 m.p.h. In his report he writes that the velocity at the top was undoubtedly greater than at the bottom and "it is no exaggeration to assume in time of storms the wind velocity at the top will be twice that at the base." The structural engineer would like to know the velocity at the top of the chimney when it is 78 miles at the base.

New Observations Needed—What is needed are observations taken simultaneously at the top and bottom of some of the existing radio towers during high winds at the lower level. It would seem that some of the 135 U. S. Government shore stations could be utilized for such a purpose. Possibly an extensometer could be used to determine stresses in a lower section of column during a high wind. Kite anemometers can be used only in moderate winds, and results obtained by them are therefore limited in application.

Wind velocities vary greatly with locations. The present writer has been impressed by this in designing sugar mills. Asking an engineer from Peru what winds a proposed mill in that country would have to resist, he was told that the wind was never "strong enough to blow off your hat." From far Formosa, where there are large sugar mills, a steel erector writes, "Up to the time I left that island all such steel buildings were calculated for a wind velocity of 150 m.p.h. This factor was decided upon after the roof had been taken off a large molasses storage tank when the Japanese wind gage in that district registered 135 m.p.h., at which rate the instrument was destroyed and therefore put out of commission."

Local Variations—At Mobile, Ala., along the Gulf coast, the highest velocities recorded in the year 1916 were 107 and 115 m.p.h., while at Anniston, in the interior of the state, 250 miles distant, the highest velocity recorded during the same year was 32 m.p.h. The highest velocity recorded in New York City for the period 1884-1921 was 96 m.p.h. This was from the present station on the Whitehall Building, Battery Place, at an elevation of 453.9 ft. above ground level. At Chicago the highest velocity recorded 1872-1913 was 84 m.p.h., in the storm of Feb. 12, 1894. This was from the former station on the Auditorium tower, 274 ft. above ground level. During this storm the wind averaged nearly 70 m.p.h. for 10 consecutive hours. (The New York and Chicago velocities for a period of 1 min. were both greater than those given). A point of interest in the Chicago observations is that while the average hourly velocity for 15 years (February 1890-June 1905) at the station on the Auditorium tower was 17.2 miles, at the station on the Federal Building (310 ft. above ground level) the average hourly velocity for 5 years (July 1905-December 1910) was 14.3 miles, or 2.9 miles less than at the previous location, 36 ft. lower. For the six months July-December 1905, registers were maintained at both buildings, and the average movement at the Federal Building was only 90 per cent of that at the Auditorium tower. This is explained by the fact that up to the time the station was moved the Auditorium tower was a comparatively isolated structure and there was a free approach to the anemometer from all sides. On the other hand the dome of the Federal Building, although rising above the former exposure, is in a way hemmed in by surrounding buildings of nearly the same height and the wind is influenced by these obstructions. ("The Weather and Climate of Chicago." Cox and Armington, 1914.)

Maximum Velocity and Pressure—It may be said here that, although average velocities have their use, the structural engineer needs the maximum velocity. He cannot design a structure for an average velocity of 30 or 40 m.p.h. when once in six months it may have to withstand a velocity of 60 or 80 miles.

Comparison of Formulae

The velocities heretofore mentioned are recorded velocities, but according to the reduction formula used by the U. S. Weather Bureau a recorded velocity (V) of 100 m.p.h. indicates an actual velocity (V_a) of 76.1 m.p.h. The pressure formula used by the Bureau, $P = 0.004\,V_a^2$, thus gives for a wind of 100 m.p.h. a pressure of 23.2 lb. per sq.ft. Many British engineers use $P = 0.003\,V^2$, which for a wind of 100 m.p.h. indicates a pressure of 30 lb. per sq.ft. As the actual velocities of occasional gusts may be near those recorded by the ordinary cup anemometers, and as the coefficient 0.004 is more than that given by many authorities, the writer believes that the assumption of 30 lb. per sq.ft. wind pressure is sufficient for towers up to 300 ft. in height unless located where winds are phenomenally severe.

Exposed Area—An important question arising in all network construction is, how much is the leeward side or face protected by the windward side. In bridges, where the trusses are but a few feet apart and the

members are of considerable size, wind currents in passing through the windward truss may be deflected and lessened in force. In radio towers, where the truss systems are widely separated and the members are of small size, it is improbable that there is any appreciable difference in wind pressure on two opposite parallel sides.

In addition to the assumptions of wind pressure and area of surface exposed to the wind, a third factor in the design of towers is the working stresses used in proportioning members. Because wind loads are intermittent and seldom reach their maximum, it seems reasonable to allow working stresses greater than those used for dead loads.

Recommended Practice—The writer recommends that radio towers be designed to withstand a wind pressure of 30 lb. per sq.ft. up to 300 ft. height. For the upper parts of *towers more than 300 ft. high* he would add 2½ lb. for every 100 ft. additional height, so that the upper 60 ft. of a 660-ft. tower, for example, would have a pressure of 40 lb. per sq.ft. (If spreader or cross-arm trusses are used the wind load on them should be assumed the same as on the upper section of tower.) For self-supporting triangular towers he would consider the area of exposed surface as 1½ times and for square or rectangular towers two times the vertical projection of one face. Working stresses of 20,000 lb. per sq.in. in tension and $20{,}000 - 90\frac{l}{r}$ in compression are recommended for combined loading.

The recommendations made are tentative. They differ slightly from some former recommendations. As previously mentioned, more information is needed on the ratio of *high* wind velocities at the ground level to velocities of points several hundred feet above. It is also desirable, but not always practicable, to have wind data regarding the particular location of a proposed tower.

Treatment of Car Sills and Decks

By Forrest S. Shinn
Tie Treating Department, Chicago, Burlington & Quincy Ry. Co.

Abstract of paper before American Wood Preservers' Association.

SINCE 1911 the Burlington railroad has treated 1,300,000 ft. of car sills and 1,800,000 ft. of car decking. We are not in a position as yet to know just what results will be obtained from this treatment, as none of the lumber has been taken out for any cause except on account of being broken; however, in view of the fact that we are taking out yearly a large amount of untreated flooring on account of rot we feel that the money spent for treatment has brought good returns. We have not made any tests on this material, comparing the strength of the treated lumber with the untreated, but from close observation have come to the conclusion that treatment very materially increases the hardness and makes it much more resistant to wear. Many untreated planks in cars built in 1911 and 1912 have been worn so thin that they have had to be replaced.

No floors or sills for open-top coal cars or flat cars have been treated but, while this flooring is not subject to conditions that will produce rot as quickly as in stock cars, I believe that from an economic viewpoint we would be warranted in treating it. I have seen hundreds of these cars where the flooring showed signs of rot to a very considerable extent and it is a very common sight to see where the sapwood along the edges of the planks has sluffed off, leaving the top of the plank in the shape of a halfmoon. This very materially weakens the floor, finally causing it to break.

Tidal Characteristics and Their Importance to Engineers

What Tides Are, How They Vary and How They Are Studied and Reported by the Coast and Geodetic Survey

By G. T. Rude
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TIDAL work in general had its origin in the necessity for reducing soundings, in hydrographic surveys, for the rise and fall of the tides. Since then the needs of the engineer and mariner have resulted in the extension of the work until it covers the following fields: Prediction of tides and the preparation of annual tide tables in advance; determination of datum planes; study of mean sea level and its relation to crustal movements; development of instruments for observing and predicting tides, and the study of tidal phenomena in general.

Tide tables containing the predictions, in advance, of the state of the tide at the different ports of the world,

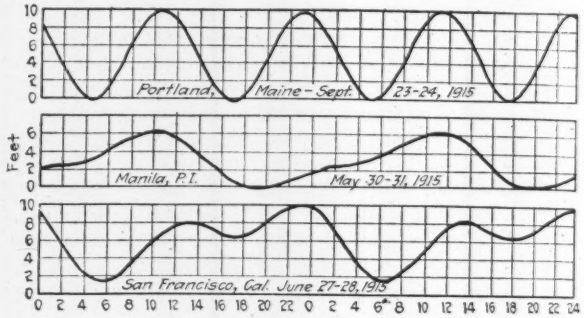


FIG. 1. THREE TYPES OF TIDE, DAILY, SEMI-DAILY AND MIXED

while of use to engineers and others, were primarily evolved for the use of the mariner, in order to furnish him in advance the state in which the tides would be at some future time, for his guidance in entering or leaving port. This information as finally evolved is contained in a conveniently arranged tide table, and consists of the time and height of each successive high and low water referred to some datum plane, usually that of the chart of the vicinity, for a year in advance.

The oldest recorded tide table appears to be the one in the library of the British Museum. It is a manuscript table written about the thirteenth century, and gives the time of high water at London Bridge, with reference to the moon's age and not for the calendar day. The British Admiralty published the first modern table in 1833. The issue of tide tables by the United States began in 1853 with a condensed table for eight stations in the United States. These tables have increased in size and scope so that they now appear annually in advance as a volume of about five hundred pages, covering the entire maritime world, with full predictions for each day of the year at eighty-one principal ports and tidal differences for more than thirty-five hundred subsidiary ports.

Prior to 1882 the tides for the United States were predicted by means of tables and graphs. Beginning with that year the predictions were made by the Coast and Geodetic Survey on the Ferrel Tide Predicting Machine (see Appendix No. 10, Coast and Geodetic

Survey Report for 1883) designed by William Ferrel of the Survey. This machine is about 2 x 3 ft. in size and is essentially a maxima and minima machine. Its small size as compared with other predicting machines was made possible by the fact that the constant representing the large or lunar component was placed directly on the face of the machine and the gearing had to take account of the differential only between this and the effects of the constants representing the smaller components. In 1910, a new machine, (see Special Publication, No. 32, Coast and Geodetic Survey, and *Engineering News*, July 20, 1911, p. 69), designed and constructed in the office of the Survey, was put in operation. It shows on its face the time and height of each successive high and low water, and at the same time draws a tide curve.

For the purposes of predictions the tide is assumed to be composed of many elementary tides, each due to the motion of moon or sun, or to their relative positions. This machine will take account of thirty-seven elementary tides. The effects of each constant representing the different components or simple waves are combined by means of a fine, flexible chain, which passes over each constant's pulley, transmitting the resultant motion to dials and pointers on the face of the machine where the time and height of each successive tide is directly indicated. It handles with equal facility the various types of tides, which are briefly explained later.

In the predictions of tides the observations obtained at a station for a year or more are subjected to the harmonic analysis which resolves the tide into its constituent waves or harmonic constants. The amplitudes and phases as secured from this analysis for each constant are set on the cranks and dials of the machine so as to sum up into the tide of nature. It is, of course, out of the question to predict the tides for all ports. To secure the state of tide at places where no full predictions are made, it is customary to refer such places to some port for which predictions have been made as a standard port. This has led to a study of the different types of tides in order that subsidiary ports may be referred to a standard port having a similar type of tide.

While there are a number of different types and forms of tides, they may be conveniently and accurately classed as three distinct types with their different forms. The main classification may be made into the semi-daily, the daily and the mixed. In Fig. 1, there are represented reproductions of the automatic tide gage records at Portland, Me., Manila, and San Francisco, illustrating these simplest types of tide—the semi-daily at Portland, the daily at Manila and the mixed at San Francisco.

In the simple form of the semi-daily, there are two high and two low waters every day; also the morning and afternoon tides are very much alike. In the simple form of the daily we have only one high and one low water a day. The third, mixed type, is caused by a combination of the two preceding types. In this we have two high and two low waters a day, but these two tides differ both as to form and height. This type is illustrated by the tide at San Francisco.

Even the simplest types vary somewhat with the moon's declination. Fig. 2, which represents reproductions of the tidal marigrams at Portland, Maine, and at Manila, P. I., illustrates the variations from this cause.

The upper curve for Portland is an equatorial form; that is, the moon's declination is nearing a minimum. The lower for Portland is the declinational form when the moon's declination is large. At this port which ordinarily has the simple semi-daily tide the curve at certain times approaches somewhat the mixed type. The curves for Manila also illustrate the case of a port which ordinarily has a daily type changed for a few days during a lunar month to a semi-daily tide when the moon is nearest the equator and the semi-daily forces are exerting the predominating influence. In the same way the tide of a port which ordinarily has a mixed type changes for a few days during the month to a

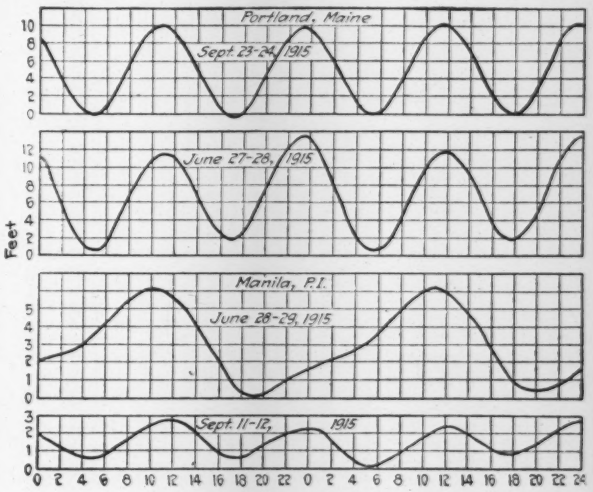


FIG. 2. VARIATION IN TIDAL CURVES DUE TO CHANGING DECLINATION OF MOON

semi-daily form when the moon has its minimum declination.

The tidal curves in Fig. 3 are reproductions of the marigrams of Seattle and Honolulu, illustrating two different forms of the mixed type.

The one at Seattle shows very little variation in the high waters but considerable difference in the lows; while the one at Honolulu shows very little difference in the height of the lows but with a marked accentuation in the difference in the height of the highs.

Briefly, this difference in form is due to the different ways in which the daily and semi-daily waves combine—they may have the same phases and different amplitudes; the same amplitudes and different phases, or both different amplitudes and different phases. It is evident, therefore, that they may combine in various ways giving rise to many different forms.

One type which has not been covered by the preceding may be called the "River Type of Tide." It is evident that fresh water run off in a river will affect the tidal wave causing the tidal curve to be steep and of a short period for the flood and more inclined and of longer period for the ebb.

There are, of course, many variations of forms, which it is impossible to cover, except as a separate subject. The types shown, however, are the principal ones.

This question of types and many other problems have required study and solution by mathematicians before tide predictions could be presented to the engineer and mariner in their present accurate state.

One of the important phases of tidal work of great

value in particular to the engineer is the determination and establishment of tidal planes of reference. The subject of datum planes would furnish material for a paper in itself. It will therefore be touched on briefly here, bringing out only the essential features of the subject and the relation of tidal planes to the work of the engineer and to the needs of the mariner.

Formerly, surveyors and engineers made use of arbitrary or local datum planes. This practice has frequently made it impossible to compare the results of recent with previous surveys. To eliminate the confusion arising from this procedure the Coast and Geodetic Survey has been establishing and furnishing datum planes based on tidal definition for all the coasts of the United States. On the Atlantic coast long series of observations are being obtained at Portland, Boston, New York City, Breakwater Harbor, at the entrance to the Delaware, Philadelphia, Baltimore and Fernandina; on the Gulf coast, at Key West, Cedar Keys and Galves-

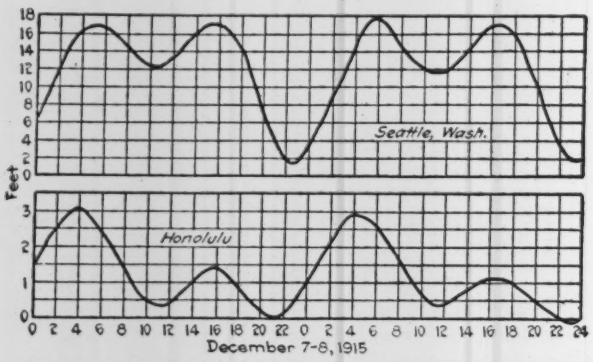


FIG. 3. DIFFERENT FORMS OF MIXED TYPE OF TIDE

ton, and on the Pacific, at San Diego, San Francisco, Seattle and Ketchikan. The observations are all connected with permanent bench marks for the use of engineers locally, or for the initial elevations or "tie in" points for precise level nets.

The great advantage of a tidal datum plane lies not only in its simplicity of definition, but also in the certainty with which it may be re-established at some future time, even if all bench mark connections be destroyed. For the purposes of the mariner a low water plane is obviously the most satisfactory, and for this reason on hydrographic charts the plane of mean low water has been adopted for the whole of the Atlantic coast. On the Pacific coast, because of the diurnal inequality of the tides, the plane of mean lower low water is in use; that is, all the soundings shown on charts of the Coast and Geodetic Survey have been reduced, no matter what the stage of the tide when taken, to mean low water on the Atlantic coast and mean lower low water on the Pacific coast and Alaska, with the exception of Wrangle Narrows, where an arbitrary plane 3 ft. lower has been adopted.

For other engineering purposes, planes such as that of high water or higher high water are at times adopted, but in general the most satisfactory plane is that of mean sea level, since it is the most easily determined and also that the other planes may be derived from it by a knowledge of the range of the tide and of its diurnal inequality.

It is evident that the planes of mean low water, mean nigh water and others are all local, since they depend on the range of the tide at any given place; that is, the

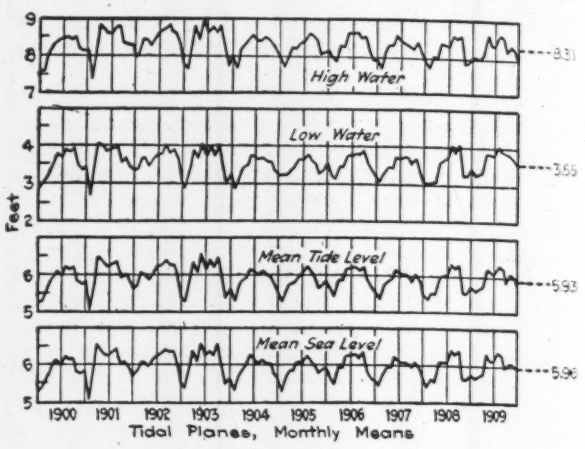


FIG. 4. VARIOUS TIDAL PLANES AS DETERMINED BY MONTHLY MEANS

planes of mean low water, etc., for the different places along the coast would, if visualized, be a wavy plane, while mean sea level may be considered as an equipotential plane forming one continuous unbroken surface. This then may be considered as the plane in which the waters of the ocean would come to rest if all disturbing influences of tide, current and wind were removed.

For practical purposes a tidal plane, determined from a series of observations covering a period of a month may be considered as being fairly well determined. Such planes, however, determined at different times may differ considerably because of long period tides and seasonal changes, and for that reason it is necessary to have long continued observations such as are being made by the Coast and Geodetic Survey at its principal tidal stations on the coasts of the United States.

The diagrammatic representation of various datum planes, as determined by monthly means (Fig. 4) brings out the fact that the determination of accurate planes of reference is not an altogether simple matter. The curves represent the planes of various tide levels by monthly means, from 1900 through 1909, at Port Hamilton, N. Y. The means of these observations show variations from month to month of as large as a foot and a half. The seasonal variations of the different planes are also very evident, being much higher in summer than in the winter months, the variations in this respect being uniform, however, for each year throughout the period. The planes of mean sea level and mean tide level (Fig. 4) are for practical purposes about the same, mean sea level being the average of all the hourly heights of the tide and mean tide level the average of the high and low waters. This difference, of course, is a minimum on a regular tidal curve and a maximum on an irregular curve. Studies of the Pacific coast tides show similar seasonal variations in the planes, except that the higher stages occur in the winter months, due to prevailing winds and rainy season.

While the difference in mean sea level as secured by means for one month, may differ as much as a foot or more from that secured for another month, the mean from a period of one year as compared with that for another year, may differ as much as a quarter of a foot, so that for a very accurate determination even a year is not sufficient.

The plane of mean sea level is a most important one, since the changes in this plane as related to fixed bench

marks on shore measure the relative changes in the emergence or subsidence of the land mass. Now, if observations extending over a year determined accurately mean sea level, the difference in this plane as between two years would measure the rate of change in this relative elevation. But it is not quite so simple; for mean sea level is subject to a long period variation upon which further study is required.

The principal tidal stations of the Coast and Geodetic Survey are so placed as to be representative of the region and to furnish tidal control for these regions. In addition to serving this purpose the records from the gages at these stations furnish the data for tidal studies, one of the most important of which is mean sea level and its changes. Continuous observations covering a number of years bring out the changes in mean sea level, thus furnishing data for a quantitative determination of relative changes in elevation of land and water.

Tidal Observations and Reductions

It is not the purpose of this paper to enter into the details of the methods used in securing and reducing tidal observations. The improvements introduced in recent years have had two aims—increase in accuracy of determination with the view to the use of results for scientific and technical, as well as for practical purposes; and decrease in the time necessary for computation. The former is being sought by improvements in the staff used for comparison with the tidal marigram by the securing of an absolutely fixed zero of staff, and frequent inspections of tidal stations connecting by spirit levels all bench marks with the tide gages at frequent intervals. In the matter of computations, improved forms tending to shorten labor and, wherever possible, the employment of graphic means of securing desired results have been devised.

The methods employed in reducing tidal observations may be grouped under two heads: Harmonic and Non-harmonic. By the harmonic method the tide wave is decomposed analytically into a number of constituent simple harmonic waves, the periods of which have astronomical definitions, while the amplitudes and phases are derived from observations. The results of the harmonic analysis are made use of by the United States in its predictions of tides. The non-harnomic is essentially a statistical method, by which the tides are tabulated for any desired argument.

The finished products of the tidal work for the use of the engineer and mariner appear in several forms: In the tide tables which foretell the state of the tide for any future time; in publications on tidal bench marks, which definitely fixes for the engineer the various datum planes over all the coasts of the United States, and in other publications devoted to a detailed study of the tides and tidal phenomena of the various ports of the country.

Newark Municipal Ownership Vote Invalid

The Supreme Court of New Jersey has declared invalid the referendum vote in Newark, N. J., in November, 1920, for a municipal light, heat and power plant. The ground for the decision is that the question on the ballot did not make clear whether the voters favored a heating, a lighting or a power plant or two of them or all three. The court gave no opinion on the constitutionality of a referendum on municipal ownership under the State home rule act of 1917.

Comparative Road-Building Costs

The cost of road construction today, according to an address before the Boston Society of Civil Engineers by Arthur W. Dean, chief engineer, division of highways, Massachusetts, averages about six times greater than that of thirty years ago. Several conditions have led to this increase. In the old days of horse-drawn vehicles, a road surface 15 ft. wide was considered adequate on all suburban roads, and in many cases a surface 12 ft. wide was sufficient. The same roads today need surfaces at least 18 ft. wide, and in many instances 24 ft. The minimum width constructed anywhere today is 15 ft. On main through lines of travel where the number of vehicles per day is sometimes as high as 3,000, the width, according to Mr. Dean, should be at least 20 ft., with a sufficient width of suitable shoulder to make an aggregate available width in emergencies of 26 ft.

On the road between Worcester and Springfield, Mass., a large amount of reconstruction has been carried on during the present year, and the width, in this case, of hardened surface has been made 20 ft. with the foundation carried out 3 ft. on each side to permit future further widening without great expense.

Another reason for the increased cost, Mr. Dean pointed out, is the necessity for improved permanent surfaces, and still another is the necessity for more adequate foundation. Where in 1895 a waterbound macadam might be built for approximately $6,000 per mile, a cement concrete or other equally strong surface and suitable foundation cost in 1921 about $40,000 per mile. In 1921 a fair average cost of a bituminous macadam surface 18 ft. wide, consisting of 4½-in. base course and a 2½-in. penetrated upper course, exclusive of all expense except the construction of pavement above the foundation was about $3 per square yard. The cost of reinforced cement-concrete surface as compared with the above is about $3.05 per square yard. Costs of construction gradually decreased during the year 1921, and the outlook, as seen by Mr. Dean, is that with this decrease in cost and with the increased use of machinery the expense of road construction in 1922 will probably be less than it has been for several years.

Thumbnail Review of 1921 Railroad Finances

Financial results of operation during 1921 of the 201 Class One railroads in the United States, as reported to the Interstate Commerce Commission, are announced by the Association of Railway Executives as follows: Net operating income was $615,625,619, which was at the annual rate of return of 3.31 per cent on their tentative valuation. This net income hardly more than covered their interest charges and rentals alone, these items amounting to $603,000,000 in 1920 and somewhat greater than that in 1921. Fifty-four railroads, consisting of 26,022 miles of track, had operating deficits in 1921, these deficits totaling $29,114,000. In 1921, operating revenues totaled to $5,569,888,000, a decrease of 10.6 per cent compared with the total in 1920. Operating expenses for the year amounted to $4,602,425,000, which was a decrease of 21.1 per cent compared with the year before. Tabulations showed that $2,019,985,000 were spent for maintenance, 23.1 per cent less than in 1920.

Railway Curves: Superelevation and Maintenance—I

Editorial Review Shows Variations in Practice and Opinion—Influence of Modern Locomotives —Relations of Curvature to Gage and Grades—Checking and Marking

By E. E. R. Tratman
Associate Editor, *Engineering News-Record*

IN RAILWAY PRACTICE, curves have not only an important relation to location but a still more important relation to operation and maintenance, since they introduce complications regarding train resistance, load, speed and safety, while they are also the direct cause of increased cost and work in track maintenance. Much improvement has been effected during recent years in reducing the amount of curvature and eliminating specially sharp curves, but this work has applied largely to excessive or extreme conditions and has not reduced the problems of curve maintenance and operation to any great extent.

It has been estimated that under ordinary traffic conditions the operating cost is increased by $1 per degree of curvature per daily train per year, and that each 12 deg. of curvature per mile adds 1 per cent to the labor cost of maintenance. These prewar figures would be too low at the present time, but they serve to indicate the financial relation of curvature to operating and maintenance. Wear and maintenance expense are assumed generally to increase directly with the central angle of curve, but investigations noted in the "Proceedings" of the American Railway Engineering Association for 1919 (p. 754) indicate that they increase as the square of the curve.

Curves in railway track affect the economy and comfort of train service and the economy of track maintenance to a large degree. Further, they represent a goodly proportion of railway mileage. Curve problems and curve work have always had a special attraction for the engineer and the accompanying article presents a comparative review of the practice of some 28 railways in regard to various curve details.

As compared with tangent track there is greater wear and displacement of rails, fastenings, ties and ballast, due to the lateral pressures exerted by the wheels, so that track material has a shorter life and maintenance work is required more frequently. Further, there is the problem of keeping curves in such condition that fast passenger trains will ride easily around them and slow freight trains will not be subject to excessive curve resistance.

Various aspects of railway curves in relation to train operation and track maintenance are dealt with in the present article, with a review of variations in practice as illustrated by information from a number of railways.

Curve elevation, or the superelevation of the outer rail on curves, is introduced to counteract the centrifugal force of trains, to relieve the rails of wear and lateral pressure, and to give a safe and easy riding movement of trains passing through the curve. But as centrifugal force varies with the speed, and trains of various speeds traverse the curve, the adjustment of superelevation to suit both high and low speeds must be a matter of compromise. Practice in the superelevaton of track curves is based largely on old time theories and tests, modified by experience under modern conditions, so that in many cases it is little more than "rule of thumb."

Since the amount of elevation for any specific conditions of speed and curve may be determined by calculation, the matter is apt to be regarded as a definite mathematical problem capable of being solved by established formulas. In fact, recent inquiry as to whether present practice is satisfactory brought some replies to the effect that established formulas are as applicable now as at any previous time, since they are based upon scientific principles which do not change. One reply stated specifically that the rules are entirely efficient and satisfactory for present locomotives and present train speeds because: "the superelevation is governed by the correct mathematical formulas and it is the speed which governs the superelevation."

Theoretically this is true, but the problem is affected by many practical conditions and by the existence of varying conditions at any one point, so that mathematical solution at best can be no more than a guide or indication. That this is the case is evidenced by the variety in practice as to superelevation, by the changes made from time to time in an attempt to obtain better results, and by numerous examples of unsatisfactory experience.

Speed is one of the governing factors in the calculation of superelevation. But no curve is operated under conditions of a single rate of speed, since fast passenger trains, local passenger trains, tonnage freight and slow drag freight trains may all operate on the same track, and perhaps in both directions on that track. There is no rule or principle or line of scientific reasoning by which the most economical and suitable superelevation can be computed when diversity of traffic and variable speed enter into consideration.

In direct opposition to the views quoted above endorsing the sufficiency of mathematical solution of the problem is the following statement by the engineer of a large road: "Speed of trains being the principal factor in determining the proper superelevation it is impossible to arrange the track to meet all conditions of traffic. For this reason we do not adopt any universal practice on a theoretical basis, but treat the matter in a practical way based on experience in order to secure the best results under the varying local conditions."

Multiple tracks which provide for separation of fast and slow trains and of passenger and freight traffic will simplify the conditions. But such trackage exists on only a small proportion of the railway system, and even there the variable conditions are merely reduced and not eliminated.

Where passenger traffic is the more important, a high speed factor may be used, but even so, the elevation

must be limited to an amount which will not injuriously affect freight trains. Further, the location of the curve may enter into consideration. Thus, even on a double track high-speed line, the actual speed on a curve near the top of a long grade or near a station will be considerably lower than on a curve located along level ground or on a descending grade. A derailment due to elevation too low for the speeds allowed was noted in *Engineering News-Record*, Feb. 26, 1920, p. 433.

From these brief statements as to actual physical and operating conditions, it is evident that the selection of superelevation for any particular curve must be necessarily a compromise, and that judgment based on observation and experience is fully as important as the mathematical calculation which may support this judgment. One of the great difficulties for men in charge of track and maintenace of way is the selection of a compromise figure which will give reasonably satisfactory results under extreme or opposite conditions.

Length of engine wheelbase is not a factor in the mathematical calculation, but it has proved to be a troublesome factor introduced in some cases by new equipment. Although most of the engineers whose opinion was asked have replied briefly to the effect that the rules are satisfactory in regard to modern equipment, two cited difficulties arising from the use of new and large locomotives, as noted later. It seems probable that further and more detailed inquiry would result in showing that similar difficulties have been experienced on many individual divisions or engine districts. Further, with heavier locomotives the wear and maintenance will be increased.

That superelevation tends to be in excess of the amount needed is indicated by several replies, some engineers advocating marked reductions from present practice. Another practical condition noted is the tendency of speed to increase with superelevation. In other words, on a curve elevated for a certain speed, enginemen who find that their trains ride easily are apt to increase the regular speed. Higher speed being noted by the track officials, increased superelevation is introduced. Slow orders or speed restrictions may be issued but it is useless to burden the engineman with many such orders, and it is obvious that these are not and cannot be obeyed with any exactitude in train service by night and day, in clear weather and in storm.

Lack of Modern Tests

In relation to this matter of the sufficiency of present rules for curve elevation, inquiry was made as to recent studies of their efficiency under modern conditions of equipment and traffic. The most definite replies were to this effect: There has been no intelligent or thorough study or analysis of the present situation, and there are no recent reliable data on the subject.

No recent tests or investigations are noted by any railway, but reference is made to textbook formulas and to the routine observations as to the riding qualities and rail wear of curves. Nor do any roads contemplate changes in their practice, according to the replies to a specific inquiry on this point.

Lack of uniformity in opinion and practice is shown clearly by a study of the curve elevation rules and tables used by a number of railways, all these lines operating both fast and slow trains. From this comparison it is apparent that for the same given conditions of speed and curvature there are variations of from 50 to 100 per cent in the superelevations specified.

Of twenty-four railroads, nineteen issue tables giving the superelevation for different combinations of curve and speed; one uses a diagram, several give formulas and two use a system of ordinates. Only two state that they follow the recommended practice of the American Railway Engineering Association but others practically conform to it. Where a table is issued it is almost invariably for general application, but at least one road has a series of tables adapted to the conditions of different divisions or portions thereof.

Examples of the variations in practice, as shown by several tables, are given below:

A. *Range in Curvature.*—As a rule the list of curves begins with 1 deg. and increases by 1 deg. increments, but in some cases it begins with 0.5 deg. In several tables there are half-degree interpolations for the flatter curves and in a few cases these interpolations vary by quarter-degrees. Two roads carry the table only to 8 deg., three carry it to 12 deg., four to 15 deg., five to 20 deg., and one each to 25 and 30 deg.

B. *Range in Speed*—The speeds listed in the superelevation tables show a wider difference than the curvature, the number of speeds given ranging from five to thirteen. Usually they begin with 10 or 15 m.p.h., sometimes 20 or 30 m.p.h. on large trunk lines, and continue by increments of 5 or 10 m.p.h. to a maximum of 60, 75 or 80 m.p.h. In one case the limit is 100 m.p.h., but this is on the diagram mentioned above and is merely an arbitrary limit for plotting the diagram, since this is not specially a high-speed road.

C. *Range in Increase of Elevation*—Of sixteen railroads, six increase the elevation by increments of ¼-in., six by ½-in. and four by ¾-in. In the first case the tables are lengthy, since there is a change with nearly every increase of curvature, but where the larger increments are used the same superelevation applies to groups of curves. In view of the extreme variation of actual speeds at any one curve, it is a question whether the ¼-in. variation is necessary or useful. Further, doubt has been expressed as to whether such close measurement or refinement is maintained in actual practice. On the other hand it is included in the recommendations of the American Railway Engineering Association.

D. *Range in Maximum Elevation*—In maximum superelevation prescribed, the range is from 6 to 9¾ in. A number of roads use 6 in. for 25 m.p.h. on 15 deg. curves to 60 m.p.h. on curves of 3 or 4 deg. Two roads use 7 in. for 45 m.p.h. on 5 deg. and 55 m.p.h. on 4 deg. curves. Four roads use 8 in. for 40 m.p.h. on 8 deg., 50 m.p.h. on 5 deg. and 70 m.p.h. on 2½ deg. Two roads specify 9 in. for 40 m.p.h. on 8 deg. and 80 m.p.h. on 2 deg. Finally, one specifies 9¾ in. as its maximum, this being for 75 m.p.h. on 3 deg. curves. The American Railway Engineering Association gives 9½ in. for 60 m.p.h. on 4 deg. curves, but recommends that "ordinarily an elevation of 8 in. should not be exceeded."

With all allowance for difference of speeds, loads, grades and operating conditions on different railways, these wide variations in maximum limit of superelevation appear to indicate divergent opinions rather than scientific deduction or operating necessity. Some roads specify that where speeds are such as to require elevations (as determined by rule) in excess of the prescribed maximum, the speeds must be reduced. It is of interest to note here that several engineers consider present elevations are excessive, but this applies to the ordinary

run of cases rather than to those which require the maximum elevation.

Summary of Variations—To illustrate more clearly the extreme range of practice in regard to superelevation under similar conditions, the accompanying table has been prepared from the tables issued by fifteen railroads. This table shows the range of elevations

TABLE OF VARIATIONS IN CURVE SUPERELEVATIONS

Speed, Miles per Hr.	1 Deg. In.	3 Deg. In.	5 Deg. In.	10 Deg. In.	15 Deg. In.
20	¼ and ½ (2)	½ to 1 (4)	1 to 1½ (4)	2 to 3 (5)	3 to 4½ (6)
30	¾ to 1 (5)	1½ to 2 (4)	2 to 3½ (4)	4½ to 6½ (6)	.....
40	1 to 1½ (4)	2¼ to 3½ (6)	4 to 5½ (5)	6 to 8½ (2)	.....
50	1 to 2 (6)	4 to 5½ (5)	6 to 8½ (4)	.....	.....
60	2 to 2½ (3)	6 to 7½ (4)	.....	.....	.....

prescribed by different roads for the same combinations of speed and curvature. The figures in parentheses indicate the number of different elevations for each combination.

For example, for a speed of 40 m.p.h. on a 5 deg. curve, there are no less than five amounts of superelevation prescribed, ranging from a minimum of 4 in. to a maximum of 5¾ in. These several amounts are 4, 5⅛, 5½ and 5¾ in. For 30 m.p.h. on 10 deg. curves, these fifteen railroads have six different elevations, ranging from 4½ in. to 6½ in. Further, for such easy conditions as 30 m.p.h. on a 1 deg. curve, there are five different elevations ranging from ⅜ to 1 in. As noted above, it is probable that on different curves for which a theoretical elevation of 3½ in. is prescribed, the actual elevations on individual curves will be more nearly 3 in. or 3¼ in. For side tracks, maximum elevations of 1 in. and 2 in. are specified.

The string and ordinate system of determining superelevation is prescribed by two roads, according to the following rule: "Superelevation of outer rail on curves shall be the length, in inches, of the middle ordinate of a string or chord equal in length to the distance, in feet, traversed in one second by the average express train." The elevation must not exceed 8 in. in one case and 7½ in. in the other. Other roads also specify this method for cases where the degree of curve is not known, the chord lengths prescribed in two cases being as follows:

32 ft. for 20 m.p.h.	64 ft. for 40 m.p.h.
40 ft. for 25 m.p.h.	72 ft. for 45 m.p.h.
48 ft. for 30 m.p.h.	80 ft. for 60 m.p.h.
56 ft. for 35 m.p.h.	.....

Here again there is diversity of practice. One road specifies the middle ordinate of a 60-ft. chord or twice the middle ordinate of a chord of 43 ft. 8¾ in. Another varies the rule according to class of track, as follows: (1) Main passenger tracks, curves under 2 deg. to have an elevation twice the middle ordinate of a 62-ft. chord or string, adding 2 in. to this amount for curves of 2 deg. and over; (2) main freight tracks, three-fourths of the ordinate as above; (3) combination tracks, the full length of middle ordinate.

Four formulas for determining superelevation on curves are given by different railways. In each of these as given below, E = the elevation in inches.

1. $$E = \frac{S^2 \times D}{1450},$$

S is speed in miles per hour, D is degree of curve and 1,450 is a constant.

2. $E = 0.00066\ DV^2$, where D is degree of curve and V is speed in miles per hour. Three roads use this, and it is recommended by the American Railway Engineering Association for ordinary practice.

3. The same as No. 2 but with 0.0007 as the figure.

4. $$E = \frac{GV^2}{32{\cdot}2\,R}$$

Here G is distance between centers of rails, V is speed in feet per second, and R is radius of curve in feet.

On curves having spiral easements or transition curves at the ends, the superelevation is made gradually on the spiral, so as to reach full elevation at the main curve. In some cases it is provided, however, that where the length of spiral is insufficient for this, the superelevation may be divided equally upon the tangent and spiral, or simply extended as far as necessary on the tangent.

For compound curves, other than spirals, it is usual to prescribe full elevation on the entire length of the main curve or curve of greatest degree, and then to reduce the elevation gradually to the amount required for the curve of less degree. While one road says simply that this reduction is to be made "gradually," others specify rates of ½ in. in 30 ft., ½ in. in 33 ft. and 1 in. in 40, 60 or 67 ft. If a spiral is used in connecting the two parts of a compound curve, the reduction must be made on the spiral. Such spirals are required by some roads when the change in rate of curve exceeds 1 deg. or 2 deg. In one case, the length of this spiral is required to be such as to increase the superelevation at the rate of 1¼ in. per second for the speed for which the curve is elevated.

Runout of Superelevation

For simple curves, without transitions or spiraled ends, the practice on twenty-two railroads is to give full elevation for the entire length of the curve, and to run it out to normal elevation on the tangent. Two roads provide for only half the elevation at *PC* and *PT.*, the runout being divided equally upon the curve and tangent with a rate of 1 in. in 60 ft. In general, the rate of runout is ½ in. per 33 ft. or per rail length, but some roads vary this from ½ in. to 1 in., according to speeds. Other specified rates are 1 in. in 40, 50, 60 and 75 ft. Still others are as follows:

A. Runout varies as degree of curve and cube of speed; 100 ft. for 50 m.p.h. and 1 deg. curve.

B. Runout 50 ft. long for 1 in. elevation and increasing by 50 ft. to 300 ft. for the maximum 6-in. elevation.

C. Up to 3 in. elevation the runout is ¼ in. per 30 ft.; for higher elevations the length is not to exceed 360 ft.

D. Rate of runout equals 1¼ in. per foot per second, taking the velocity in feet per second for which the curve is elevated.

Runout for spiraled curves has been noted above under the heading "Spiral and Compound Curves."

A difficulty which, as a rule, must be overcome arbitrarily and to suit local conditions, is that of providing runout for superelevation of reverse curves or of curves separated only by short tangents. Reverse curves in main track are prohibited by some roads. To eliminate the condition of short tangents, one road has made a point of substituting one long curve for two short curves or of separating the curves so as to provide each with suitable spirals and corresponding runouts.

In one case the rule is to divide the short tangent into two parts, in proportion to the degrees of the curves which it connects, the longer portion being adjacent to

the sharper curve. At this dividing point the track is level transversely and the runout is made in each direction, extending onto the curves as far as may be necessary. The rate of runout varies from ½ in. in 30 or 33 ft. to 1 in. in 30, 40 or 50 ft. For reverse curves, having no intermediate tangent, the runout is made in both directions from the point of reverse. Some roads reply simply that such conditions are matters for local study, or that superelevation is reduced in order that a proper runout can be secured. Two rules mentioned are as follows:

A. Between curves provide a stretch of level track equal to the length of the longest passenger car. A modification of this rule provides a fixed length of 30 ft.

B. When both curves are in the same direction, maintain the superelevation on the short tangent.

SELECTION OF SUPERELEVATION

For individual curves the superelevation is prescribed usually by the engineer of maintenance of way, division engineer or roadmaster, due regard being given to the speed of trains, the adjacent profile and alignment and the local operating conditions. The necessary instructions are then given to the section foreman, who sometimes is provided with a list of all curves on his section, showing their degree and superelevation.

The difficulty of thus selecting the elevation which will best suit the particular curve is indicated by the fact that several railways issue instructions to the effect that if there are indications of excessive or insufficient elevation, the necessary adjustment in elevation of rail or speed of train will be recommended by the roadmaster or engineer. Instructions as to changes in elevation made necessary by alterations in train schedules or speeds are issued by the engineers. In many cases a record of the approved superelevation on all main track curves is kept by the engineering department.

(To be concluded)

Interstate Water Supply Certification

Of the 3,102 sources of water supply of interstate carriers (railway and steamship) on records of the United States Public Health Service for certification, 1,309 or 42 per cent were certified as satisfactory by the Service during the year ending June 30, 1921; 339 or 11 per cent were certified provisionally; 143 or 5 per cent were classed as polluted; and no rating was made for 1,311 or 42 per cent. The reason for leaving so many sources unrated, according to the 1920-21 report of the Surgeon-General of the Public Health Service, was "lack of personnel and appropriations in the Public Health Service and the various state health departments." This control rests primarily with state health departments, where such exist and are qualified for the work, the Public Health Service marking the state reports as favorable or unfavorable. The country is divided into nine sanitary districts, each in charge of a sanitary engineer of the Public Health Service. The certification extends to any carrier line which, in connection with one other carrier makes it possible for a person to travel "without unnecessary delay from one state to another." Of the 3,102 sources of supply already mentioned, the ownership of 1,950 is municipal, 413 private and 739 railroad.

Local Pit Road-Graveling Costs and Performance

Outfit Described—Performance Recorded in Terms of Delays and Output—Costs Include Overhead and Camp Expenses

By J. A. Prior
Highway Engineer, Red Wing, Minn.

A ROAD-GRAVELING outfit was operated last year in Goodhue County, Minnesota, under conditions which give the cost and performance records a representative value not often presented by such figures. In 1921 the county had two jobs of road graveling aggregating 24.5 miles. A total of 31,394 cu.yd. of gravel from five pits was loaded. Of this volume, 22,749 cu.yd. from four pits were screened and pebbles over ¾ in. were crushed. The remaining 8,645 cu.yd. was pit run. The

MAIN EQUIPMENT OF PORTABLE GRAVEL PLANT

operating season was from April 15 to Dec. 31, and during this period the plant was moved four times, two moves of 6.5 miles each, one move of 9 miles and one move of 30 miles.

A camp was established at each location of the plant. Its equipment was one 24-man cook car, a 32-man bunk car, a water wagon and a Ford service car. To take the gravel from the pit to the screens and crusher there were one double-drum 40-hp. hoist, with mast and cable, a 20-cu.yd. bin and slide, a 1-cu.yd. drag bucket and a 500-gal. water wagon. The screening and crushing equipment comprised a ¾-in. shaking grizzly, a 9 x 13-in. jaw crusher, a bucket elevator, and a 40-60 gas tractor. Power for the grizzly was taken from the upper shaft of the elevator. The screen and crusher had a capacity of 30 cu.yd. an hour, with gravel running 25 per cent over size. At the pits worked the oversize stones varied from 25 to 35 per cent. The hauling was done with eight 3½-cu.yd. army trucks with 3-cu.yd. dump bodies and hoists. There were also a 500-gal. gasoline tank on wheels and a supply car containing truck and repair parts having an inventory value of $2,998. A field shop was provided with a welding outfit, hand wall-drill, forge, engine stand and hand tools, inventoried at $1,031.

In explanation of the costs given in Table I, it may be stated that the camp is self supporting as to food, service and upkeep. Interest and depreciation are charged under overhead as rent of camp equipment at $2 per day. They are apportioned, as are all joint expenses, as follows: loading, 40 per cent; hauling, 40 per cent; and screening and crushing, 20 per cent. The county carries its own accident insurance, settling with

TABLE I—FORCE ACCOUNT COST OF GRAVELING ROADS IN GOODHUE COUNTY, MINNESOTA, FROM LOCAL PITS WITH A PORTABLE PLANT

	Amount	Per Cu. Yd
Loading:		
Labor, engineer, fireman, foreman, etc.	$3,398.23	$0.108
Oil and grease	75.85	0.002
Coal, 138½ tons	1,501.04	
Hauling by trucks @ $2.50 per hour	357.75	
	1,858.79	0.058
Water, labor, team	587.15	
Gas and oil	88.02	..
Repairing, pump and engine	48.80	
	723.97	0.024
Moving	2,250.68	0.072
Repairing, hoist engine	149.33	
Bin and slide	380.44	
Mast, cable and sheaves	122.35	
Miscellaneous	114.67	
	766.79	0.025
Depreciation, hoist engine	670.00	
Bin	134.00	
Bucket	67.00	
Mast, cable and sheaves	134.00	
	$1,005.00	0.033
Overhead, superintendence	508.79	
Timekeeper	692.10	
Rent of camp equipment	242.25	
Rent of camp grounds	38.80	
Rent of shop and supply cars	26.30	
Insurance	28.00	
	$1,536.24	0.048
Total loading	$11,615.55	$0.370
Screening and crushing	$944.77	$0.042
Gas		
Oil and grease	320.98	0.014
Labor	1,549.38	0.068
Moving	562.67	0.024
Depreciation tractor	735.00	
Screen	210.00	
Rock crusher, elevator	1,050.00	
	$1,995.00	$0.088
Overhead, superintendence	254.40	
Timekeeper	346.06	
Rent camp equipment	121.14	
Rent of camp grounds	19.40	
Rent of shop and supply cars	26.30	
	$795.30	$0.035
Repairing, tractor	$331.09	
Screen	116.71	
Rock crusher and elevator	197.13	
	$644.93	$0.028
Total screening and crushing	$6,813.03	$0.299
Hauling:		
Gas	$3,609.58	$0.049
Oil	922.21	0.012
Grease	214.00	0.004
Labor, drivers	4,579.50	0.059
Truck parts	2,369.25	0.033
Truck supplies	355.95	0.006
Repair labor	1,138.05	0.015
Depreciation @ $0.10 per mile	4,870.00	0.066
Overhead superintendence	1,326.76	
Mechanic	1,497.35	
Timekeeper	692.10	
Rent of camp equipment	242.25	
Rent of camp grounds	38.80	
Rent of shop and supply car	228.17	
Insurance	14.00	0.041
Total hauling	$21,087.97	$0.285

the claimant under the Workmans' Compensation Act of Minnesota. The amount paid out has not exceeded $100 in any of the last five years. The insurance for 1921 was $70 as against $1,322 which would have been the premium on the total county pay roll for liability insurance. The cost under "timekeeper" includes his wages and the upkeep, depreciation and operating cost of a car.

The cubic yard-mile consumption was:

Gas	0.2317 gal.
Oil	0.0555 qt.
Grease	0.0171 lb.
Driver's time	0.1110 hr.

Loading, screening and hauling performance was:

Loading and Screening, Performance Records

	Hr.	P.C.
Time working	1,337	61.6
Time delayed for weather	414	19.1
Time delayed for repairs	48	2.2
Time delayed for moving	571	17.1
Total time, 217 10-hr. days	2,170	100.0

Monthly Average Outputs		Cubic Yards per Day
April	130	Sept. 210
May	297	Oct. 200
June	250	Nov. 238
July	230	Loading only
Aug.	220	Dec. 326

Average for working time, 234 cu. yd. per 10 hr.

Hauling Performance Records

	Truck Hours	P.C.
Time working	8,274	47.8
Time delayed for weather	3,178	18.3
Time delayed for repairs	2,884	16.5
Time delayed no driver	66	0.3
Time delayed for moving	2,601	15.3
Time delayed for gravel	357	1.8
Total time, 217 days	17,360	100.0

Monthly Average Output per Truck per 10 Hours,		Cubic Yard-Miles
April	66.6	Sept. 95.6
May	87.3	Oct. 96.8
June	78.8	Nov. 100.8
July	88.9	Dec. 90.2
Aug.	92.3	

Season's average, 90.3 cu.yd.-mi. per 10 hours
Season's average length of haul, 2.5 miles

German Sewage-Works for Houses and Public Buildings

BY KARL HALLER
Doctor of Engineering, Langenau in Wurttemberg, Germany

IN Germany, and especially in Württemberg, the official regulations and measures for the protection and furtherance of public health are stringent. This applies especially to water supply and sewage disposal. For public buildings, such as concert and lecture halls, theaters, schools and hospitals, sewage treatment plants are always required. In towns, which have a flushing system, the sewage tanks are arranged for flushing with water. How this is done is quite simple. Small buildings, run on business lines, will be shown here by means of a few examples.

For connecting the sewage pipes from houses to the municipal sewer system in the town of Ulm, the so-called "Ulm tank" (Fig. 1) has been developed. For building such tanks for water closets, the municipal police issues the following regulations:

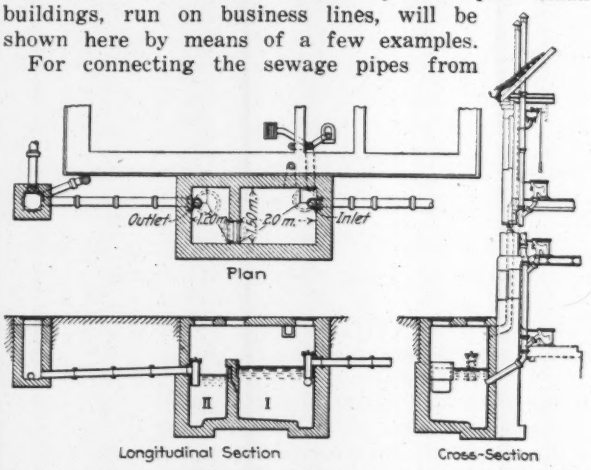


FIG. 1. TANK BETWEEN HOUSES AND SEWERS AT ULM

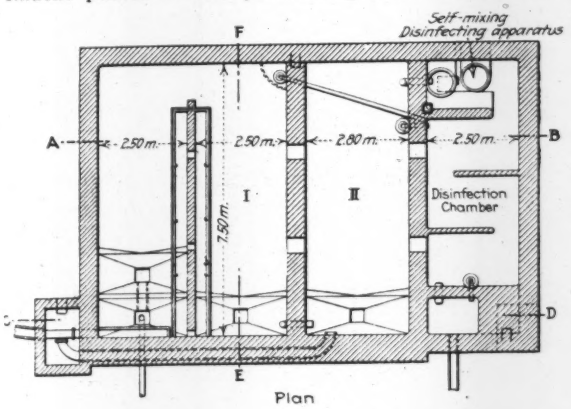
1. The size of tank [compartment] I is to be calculated so that for each inhabitant of the house 120 liters are allowed; minimum size, 2 cu.m. For tank [compartment] II half of the numbers for tank I are taken.
2. Normal depth of water is 1.20 to 1.50 m.
3. The water level in tank I is 20 cm. lower than in tank II.
4. Ventilation must be carried above the roof.
5. The width of overflow from tank I to II must be at least 50 cm.
6. The depth of immersion for supply pipes and effluent pipes as well as for overflow baffles is 30 cm. below the water level.

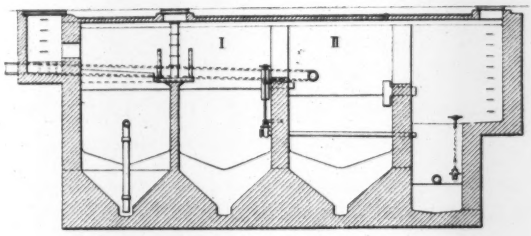
The tanks must be completely watertight, and must have sumps for emptying, and tightly fitting covers.

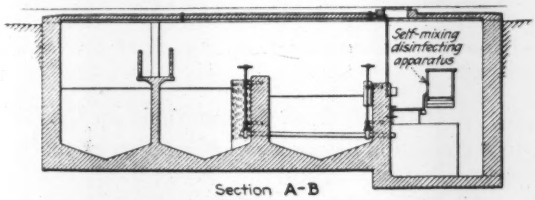
Fig. 2 shows a biological sewage purification plant [settling tank and percolating filter] for a lecture hall at Stuttgart. The building has space for 1,375 people, for whom there are provided 24 water closets, 4 urinals, and 22 m. of urinal wall. The daily flow therefrom is calculated as follows: 120 liters (29.7 gal.) each, for 5 persons in the janitor's building, 60 liters each for 70 persons in the janitor's staff and 6 liters each for the audience of 1,300, making a total of 1,260 liters (333 gal.) a day.

To clarify this quantity of sewage, tanks and a filter of the dimensions and capacity shown in the accompanying table were provided.

The sewage flows over a weir 0.80 m. wide to a digestion tank. An immersed baffle board, reaching to a depth of 30 cm. and extending 20 cm. above the water level, retains the floating scum. The digestion tank effluent passes to the percolating filter through main







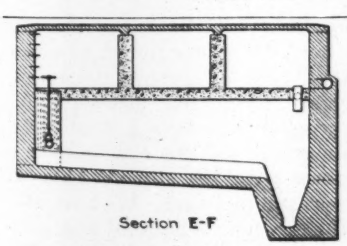


FIG. 3. SEWAGE SETTLING AND DISINFECTING TANKS FOR HOSPITAL AT ULM

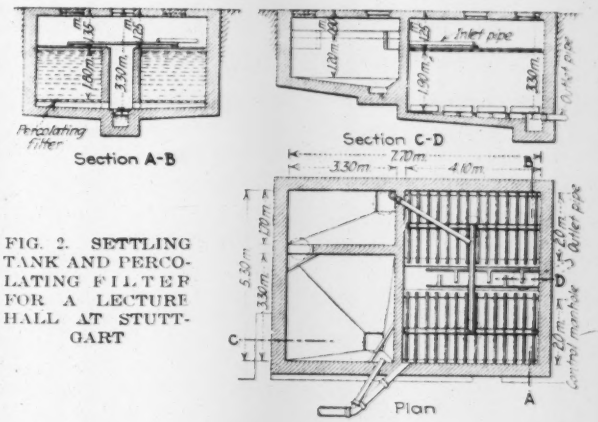


FIG. 2. SETTLING TANK AND PERCOLATING FILTER FOR A LECTURE HALL AT STUTTGART

and branch gutters. The main gutters are of channel iron, 14 cm. in width, 6 cm. in height, supported on pipe at intervals of 30 cm. and having their upper edge so adjusted as to give uniform discharge of the sewage along their whole length. The percolating gutters are

ELEMENTS OF SEWAGE-WORKS FOR STUTTGART LECTURE HALL

	Dimensions in Meters				
	Length	Width	Surface	Effective Height	Effective Capacity Cu.M.
Collecting tank	3.30	3.30	10.00	1.20	12.00
Digesting tank	3.30	1.70	5.61	1.20	6.73
Percolating filter	4.10	1.00	16.40	1.50	24.60

of L iron, into whose upper edges notches are filed at intervals of 5 cm. in such a way that percolation takes place uniformly along the whole length. The gutters are protected from rusting by a coat of paint.

The percolating filter, 1.50 m. deep, consists of slag and is provided below with a space for ventilating which can be washed out from a hydrant in the controlling manhole. In this manhole a disinfectant may be introduced if need be. The tanks and the percolation filter are provided with ventilation pipes.

Another plant, that of the hospital at Ulm built during the world war, is shown by Fig. 3. In view of the great danger of infection from hospital sewage, a constantly operating disinfecting device was necessary at this plant. In order to be able to put the digestion tanks out of commission alternately for cleaning or repairing, a circulating line to tank II is provided and equipped with a slide valve. The incoming sewage flows over an overfall into tank I, then runs slowly round the baffle wall, and then, after sedimentation of the floating scum, goes to tank II over a weir 0.2 m. long. After further clarification it runs through an exit, also 0.2 m. in width, at the opposite end of tank II, to the disinfecting apparatus in the disinfection chamber. The upper mixing tank is operated automatically. After four years of operation the plant has given entire satisfaction.

Definition of Ethics

Ethics may be defined as an expression of undivided principles of action for the guidance of the members of a group or profession in their relations with other members of the group, so as to insure as far as possible equity and justice to all.—Prof. H. E. Rigg before Michigan Engineering Society.

Concrete Dam 22 Feet High Built With Traveling Form

Timber Frame Spanning Site and Riding on Rails on Foundation Carries Steel Spillway Form by Adjustable Rods

IN CONSTRUCTING the concrete spillway in the earth dam for the new water supply of Danville, Ill., a steel form was suspended within and braced from a timber traveler, as shown in the sketch herewith. This spillway, 22½ ft. high above the foundation course, and 470 ft. long, was built in sections 18 ft. long, each section requiring about 250 cu.yd. of concrete.

The concreting of the spillway was divided into three stages. Alternate sections of the downstream apron were placed first and then alternate sections of the 6-ft. foundation course, this latter being 30 ft. wide and extending 2 ft. beyond the upstream face of the dam. Two longitudinal ribs on this base form a key with the body of the dam and a channel or recess forms a seat for the toe of the curved downstream face. The third stage was the pouring of the 18-ft. sections of the spillway. Vertical recesses 6 x 36 in. are provided to key the sections together. Two recesses in the top of the spillway (Fig. 2) will permit the hinged steel frames of the flashboards to be lowered during high water.

The steel form, 20 ft. long, is built up of plates and angles, each plate 1 x 5 ft. having a hole and cover piece so that tie rods may be placed in any desired number and position. More rods were used than are shown on the drawing. A wooden bulkhead at one end was held in place by 1-in. tie rods screwed into malleable iron sleeves attached to rods in the adjacent concreted section of spillway. Similar sleeves were used also on the 1-in. transverse tie rods between the front and back faces of the form. These sleeves were placed just inside the form, so that the short rods could be unscrewed and the holes filled with concrete or mortar. The tie rods pass through waling timbers on the outside of the form.

To carry this steel form, a traveler 30 ft. high and 32 ft. wide was built. Each side sill was carried by four 9-in. double-flanged wheels riding on a rail. These rails were spiked to timber stringers laid on the concrete base course, as shown. Suspension rods and brace rods with adjusting ratchets hold the form in position, the concrete toe being secured also by a waling timber fitted to anchor bolts embedded in the concrete base.

This steel form was designed by the Blaw-Knox Co., Pittsburgh, Pa., for L. N. Cope & Son, Decatur, Ill., the contractors for the dam. The consulting engineers are Pearse, Greeley & Hansen, Chicago, with J. Albert Holmes as chief engineer in charge of the construction work.

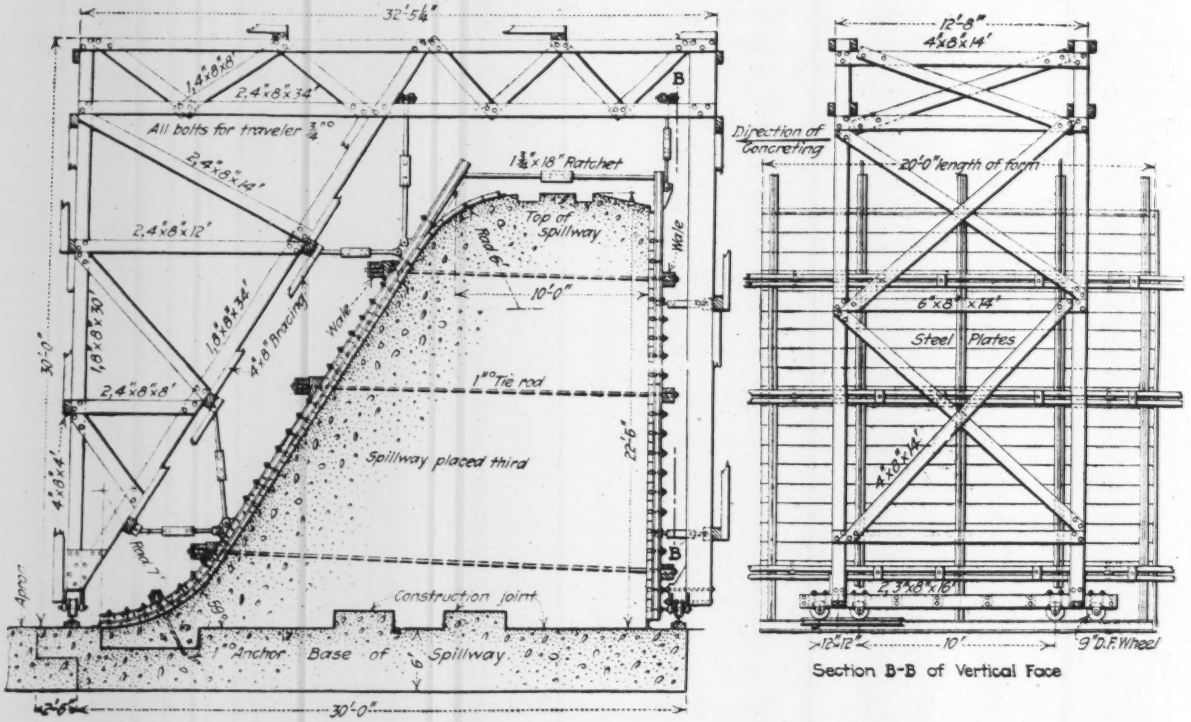


FIG. 1. DOWNSTREAM SIDE OF TRAVELING FORM FOR CONCRETE DAM

A Detail of Road Foundations on Clay

In a discussion before a recent meeting of the Boston Society of Civil Engineers John R. Rablin, chief engineer, park division, Metropolitan District Commission of Massachusetts cited the following experience with road foundations: "We have found, where we have a clay subgrade, that if we lay crushed stone or a coarse gravel over it, before laying our macadam, in a few years, if we have occasion to excavate, most of the stone seems to have disappeared and the clay to have come to the surface or mixed with the stone. This action is probably due to frost and moisture. We have also found that by covering the clay with a layer of fine sand before putting on the coarse gravel or stone, it will prevent that to a large extent."

Ontario "Hydro" Condemned As Wasteful and Expensive

W. S. Murray Investigates Leading Government Owned Power System for the National Electric Light Association

AS a result of an investigation made for the National Electric Light Association and taking over six months' intensive work, W. S. Murray, electrical engineer of the firm of Murray & Flood, New York City, concludes that the Hydro-Electric Power Commission of Ontario, the leading example of a government owned utility on the continent, is inefficient, expensive and wasteful, and that notwithstanding all the claims made for it, service from private utilities in the United States and in Canada is cheaper. These conclusions are set forth at length in a 225-pp. book entitled "Government Owned and Controlled Compared with Privately Owned and Regulated Electric Utilities in Canada and the United States," which has just been published by the National Electric Light Association.

The report gives a brief history of the commission, outlines the development of the powers which have been given it, contrasts its operation with that of a private utility under government regulation in the United States, discusses the effect of the remission of taxes on the Ontario development, investigates fairly thoroughly the expense of the new Queenston-Chippawa development and the recently completed Nipigon development, outlines the peculiar rate method of the commission, and finally makes an elaborate comparison of the cost to consumer of power and domestic electricity in Ontario, in Quebec (where there is a large degree of government control but little government ownership), and in the private companies of the United States. The main conclusions of the report are given in the box which accompanies this abstract. The detailed information below is taken from the report.

The Hydro-Electric Power Commission of Ontario is a growth from a league of seven municipalities formed in 1907 to control the delivery of Niagara power to these municipalities. It has now become a commission acting variously as a public service commission, an engineering company, an electric utility company, a holding company, a construction company, a banker, a manufacturer, a supply dealer, and an underwriter's inspection bureau. It has exclusive jurisdiction as to all matters conferred upon it and nothing done by the commission within its jurisdiction is open to question or review in any action or proceeding or by any court. No suit can be brought against the commission without fiat from the attorney general, and to date no such fiat has ever been granted. Its investments now total nearly $200,000,000, the bonded indebtedness of which is guaranteed by the Province of Ontario. This amount in 1920 represented 70 per cent of the debt of the province itself. The commission, however, is independent of the government of Ontario, except that two of the three members may be and one of them shall be a member of the government. The chairman, Sir Adam Beck, however, has held his office through a succession of governments since the formation of the commission.

All property held by the government electric utilities in Ontario is tax free with the exception of that appli-

Abstract of W. S. Murray's Conclusions on Ontario "Hydro"

AFTER a careful analysis of the governmentally owned, controlled and operated electric utility structure as represented in the Hydro-Electric Power Commission of Ontario, I am of the opinion, first, that the principles of its application can find no place in the United States; second, that to attempt the substitution of its principles of control and operation within the States would not only be to strike a blow at economic structures the present existence of which is far better equipped to protect the public interests in their conjunctive relation with the public service commissions of the states regulating their rates, but it would also be to strike an equal blow at the shareholders of the electric utilities which are now serving the American public; and, third, that the Hydro-Electric Power Commission owes its being only to the fact that a public service commission on the order of those operating in that States was not in existence in the Province of Ontario at the time of its creation.

I support the above statement in the following conclusions:

Power as applied in Ontario from the governmentally owned and controlled system in associate relationship with the Hydro-Electric Power Commission to be superior in kind to that supplied by the privately owned electric utilities of the United States must be more adequate, more reliable and cheaper. The facts show, however, that the electric utilities of the States hold more power in reserve and sell more energy per capita served; that by that token they can claim a greater reliability of supply and that the supply is cheaper to the consumer.

At the end of the fiscal year 1920, out of the total power-plant capacity operated by the Hydro-Electric Power Commission only 23 per cent was constructed by the Hydro-Electric Power Commission. The remainder represents plant capacity constructed at the initiative and risk of private investors, and in acquiring ownership of it such intangibles as franchise rights, good will and other intangibles were included in the purchase. This intangible cost, therefore, is represented in power "at cost."

The building of new power-plant facilities under the auspices of governmental ownership, as shown in the cases of Nipigon and Chippawa, both in respect to policy and cost, is not to the economic interest of the people.

The advocates of government or municipal ownership of electric utilities claim reduction in the cost of power in virtue of (a) elimination of taxes, (b) elimination of dividends, (c) elimination of high-salaried executives, (d) more economical wage and higher efficiency in labor scale.

With regard to (a), taxes are not eliminated. Just as much money in taxes is paid. The difference is in their distribution. In the case of private ownership, only the users of service pay the tax bill, while in the case of government-owned utilities all the people pay the bill.

With regard to (b), (c) and (d), notwithstanding dividends, high-salaried executives and the wage and labor claim, the answer is that, when the total operation are summed up, the people receive the power at less cost through private ownership under regulation.

The Hydro-Electric Power Commission is the judge of its own acts. A commission cannot fairly be the judge of its own (and others') rights in contentions.

The American companies in the Niagara district are supplemented by steam power far more than those on the Canadian side, and yet on the American side power is being furnished at less cost to the people.

The commissions of the States fully realize that protection to the people lies in protection to the electric utilities from which they are receiving power. The authority delegated to them to regulate rates, and the constitutionality of the law standing behind any action on their part or on the part of the electric utilities, provides a structure constructively balanced to do justice to all parties.

able to land, so that the effect of taxes on the apparent cost of power in Ontario is insignificant. With all of his computations, however, Mr. Murray has compared the cost of the government power with private power with the tax charge deducted from the latter. It is obvious that the taxes cannot be eliminated but are merely distributed to people in general rather than to the users of current.

The rate structure adopted by the commission is different from that used anywhere else. Each of the separate systems in the network has a power center. In the vicinity of that center the cost of power is a minimum. At the point farthest from the center, measured in transmission distance, the cost is maximum. Several systems overlap zones and power sold to a municipality from one system may be at a price more than 500 per cent higher than that sold to a municipality within the same zone but receiving power from another system. The commission uses an interim wholesale rate, which is an estimated rate to municipalities. At the end of a year a municipality is credited or debited, depending upon whether actual cost has been lower or higher. In every city, however, the individual consumer rate, that is the rate which the ordinary citizen has to pay for his house service, is low, though the power rates charged to the large user as a rule are higher than in comparable regions in Quebec or the United States. In the 1920 annual report of the commission the interim wholesale rates for 169 municipalities are given, while the actual wholesale rates paid can be computed for 174 municipalities. The highest interim wholesale rate that was quoted in this report was between $80 and $90 per horsepower year, while the highest actual wholesale rate paid per horsepower was between $150 and $160 per horsepower year. Altogether there were nine municipalities which paid a rate higher than the maximum interim rate quoted.

Public vs. Private Operation

The report has many pages of statistics comparing government owned and privately owned utilities. In Ontario the province owned in 1920 approximately one-half of its electric utilities, and of the total utility income two-thirds was derived from those governmentally owned, while in Quebec the government owned utilities representing but 4 per cent of the investment in that class of property receive about 5 per cent of the total revenue therefrom. The report shows that the cost of power to the entire people of the Province of Quebec and to the American Niagara district is less than to the people of Ontario. In respect to economic operation, as between governmentally owned and privately owned electric utilities in Ontario and Quebec, it is shown that the operating ratios between the privately owned and the governmentally owned companies indicate a much lower per cent for the former.

In the Niagara district of Canada it is shown that the government owned electric utilities furnish power at 9.25 mills per kilowatt-hour generated, the private electric utilities at 7.6 mills, and the weighted average of the two supplies is 8.78 mills. In the United States, for comparable zones supplied by Niagara Falls power, the average price of power to the consumer is 7.65 mills per kilowatt-hour generated. In the Province of Quebec, the average cost to consumer is 6.6 mills. The average cost of power, that is revenue per kilowatt-hour generated, for the American Niagara power district is about 17 per cent less than that for the total operations of the Hydro-Electric Power Commission and the municipal commissions for wholesale power delivered in the Canadian Niagara district, and it is about 13 per cent less than for all electric utilities in that district.

Comparing the average cost of retail power to the people residing within municipalities served by the Hydro-Electric Power Commission of the Niagara district, it is found that the average cost of power to the people in the American district is less by 4.45 mills per kilowatt-hour, or 40 per cent, and furthermore that the American district has a capacity per thousand of population 65 per cent in excess of that in Canada.

Other figures are given to show that the operating costs in "Hydro" are not as low per unit as in the privately owned plants.

A final chapter gives some cost figures on both Chippawa and the Nipigon developments. For the former, the largest hydro-electric power development in the world, it is stated that some confusion exists on its probable maximum output, which is variously estimated from 495,000 to 650,000 hp. Estimates and costs on this work have gone up steadily since it was projected in 1917. A number of reasons, mainly the effect of war increases and certain added expenses due to an effort to make increased speed last summer, are responsible for this. Mr. Murray shows that whereas the commission formerly purchased 100,000 hp. from the Ontario Power Co. at somewhat more than $9 per horsepower per year, the cost of power to the municipalities of Ontario from the Queenston-Chippawa development, *based on the diversion of water in accordance with existing international treaties*, will be $28.05 per horsepower year plus $9.40 for transmission from Niagara Falls to the municipalities, or $37.45 in all. With unlimited diversion of water the cost for power when the Queenston-Chippawa plant is constructed to a capacity of 275,000 hp. will be about $21.30. However, Mr. Murray shows that when the Queenston-Chippawa development is ultimately completed and is handling a load of 600,000 hp. based on the use of 20,000 sec.-ft., provided there is sufficient water available so that none of the capacities of the other power plants on the Canadian side need be closed, the cost will be $12.60 per horsepower year.

Abrasion Tests of Aggregates Disagree

Tests indicate that the type and per cent of wear of the aggregate has little influence on the compressive strength or wear of the concrete for pavements. In a recent series of investigations, by Prof. D. A. Abrams at Lewis Institute, of the abrasive resistance and concrete making properties of about 150 different samples of coarse aggregate, four methods of testing, for wear, the A. S. T. M., the Mattimore, the Rea and the Abrams, were compared. The A. S. T. M. method gave the lowest per cent in each instance. The Mattimore method gave about double the value by the A. S. T. M. method and the Rea method about double that by the Mattimore method. The Abrams method gave values which averaged about the same as the Mattimore method. The different methods did not give the same rating to the different types of coarse aggregate. The values for gravel by the A. S. T. M. method were absurdly low. It is difficult, states Professor Abrams, to draw any conclusions from these tests, except to suggest a grave doubt as to whether any of the tests has any significance when applied to aggregates for concrete roads.

ENGINEERING LITERATURE

An Unsatisfactory Compilation

REVIEWED BY F. W. SCHEIDENHELM
Consulting Engineer, New York City

HYDROELECTRICAL ENGINEERING: A Book for Hydraulic and Electrical Engineers, Students and Others Interested in the Development of Hydroelectric Power Systems by Richard Muller, Electrical Engineer. Formerly Consulting Engineer for the Government of Ecuador, S. A. New York, London, Leipzig and Paris: G. E. Stechert & Co. Cloth; 7 x 10 in.; pp. 431; 395 illustrations in the text; half-tone frontispiece and diagram on folding plate; 74 tables. $6 net.

The good in this book lies essentially in the matter which is made available from Continental sources and in a few detailed discussions giving evidently the results of the author's own work. It is regrettable that the author has not made more effective use of his apparent familiarity with the German and French and probably also the Italian languages, for the engineering profession would benefit greatly from a mere compendium of practice in the field of hydro-electrical engineering throughout the world, provided only that such a compendium were reasonably complete in scope, well-balanced and above all up-to-date. To these characteristics the compilation before us can not lay claim.

Briefly, the volume takes up hydrology, canals, pressure pipes, dams, turbines and other machinery, transmission lines, water-power economics, various existing developments and water-power legislation.

A foreign "accent" is evident in the diction and the text is replete with loose phraseology, inconsistencies and plain errors. Such faults could be overlooked if the essentials of a good compilation were present, if the further search and study of the reader were aided by suitable references to sources and if, conversely, those sources were given proper credit by reference.

Completeness of treatment of the subject would require much more extensive discussion of the storage of water against the needs of the peak load or of the dry season. A discussion of dams which purports to be broad should not omit mention and illustration of the multiple-arch type. The automatic and semi-automatic types of hydro-electric plants are too important, both in their present use and their still greater prospects for the future, to warrant their omission. The vertical-shaft type of generator, not mentioned in the section on Alternating Current Generators, is now the predominating type where reaction wheels are used, thanks to the perfecting of the vertical thrust bearing. The treatment of the latter, too, is inadequate.

The lack of balance is illustrated by the fact that about 50 pages are devoted to the subject of Pressure Conduits (including 9 pages of abstract from a French article analyzing elaborately a self-supporting penstock bridge), whereas to the subject of dams there are devoted only about 40 pages and to a chapter combining the Investigation of Water Power Projects and Economics there are devoted only about 20 pages. Yet in the preface the author assures us that he particularly had in mind, among other things, the needs of engineers reporting on the "commercial success" of hydro-electric developments. That no consistent program has been followed is evident from the casual occurrence of "problems" in Chapters III and VIII, and the fact that the discussion of operating methods is limited practically to the comparatively unimportant rotary-converter.

To show that the book is not up-to-date, one might point to the failure to mention the plunger type of hydraulic valves, or the newer and more efficient types of draft tubes or the far greater efficiencies obtained nowadays from the reaction turbine than from those indicated in the text. Perhaps the most glaring offender in this respect is Chapter IX, Description of Hydro-electric Plants. This touches lightly about 40 plants, of which about a dozen are European, with heads running to 4,600 ft. To be sure, the chapter is of some value to the novice and even to the experienced hydro-electrical engineer. However, the last seven years have been years of great progress in this field and no present work is complete without recording that progress. Yet in general the plants described in this chapter antedate 1914 and some even 1908. A welcome exception occurs in the case of extracts from a 1921 *Electrical World* article on the Queenston-Chippawa development of the Hydro-Electric Power Commission of Ontario.

The same chapter shows lack of references. Dates of design and construction are rare, whereas they should be the rule so as to inform the reader of what stage of the art the plant is contemporary and illustrative. Frequently throughout the book data and formula are given the impress of finality but without either derivation or reference to an authority. Even when the name of the authority is mentioned, there are often left in the reader's mind the questions: Who is he? In what year did he say it? Where is it to be found?

In the matter of giving credit to those who have contributed to the world's knowledge or literature data which are of sufficient value to be copied, this book is a glaring example of a lamentable tendency. Thus, Chapter II is largely from Hoyt and Grover's "River Discharge" and from Water Supply Papers 94 and 200 of the United States Geological Survey, mainly without credit. Mead's "Water Power Engineering," especially the first edition, is copied as to figure and text time and again, and apparently only in a single footnote is credit given.

In Chapter IV the author makes the nearest approach to justification for writing his book. Here, in treating pressure pipes, he includes considerable material from foreign sources and presents a number of helpful diagrams for the selection and design of riveted steel pipe. Much of this matter is evidently original with the author. Likewise his transmission line calculations are reasonably comprehensive and representative of modern practice. However, it is not believed that these and the all-too-few other good points to the author's credit are sufficient excuse for the book as a whole. One is left with the impression that it is a *potpourri*.

Vented and Unvented Traps

REVIEWED BY GEORGE C. WHIPPLE
Professor of Sanitary Engineering, Harvard University, Cambridge, Mass.

PLUMBING FIXTURE TRAPS: An Historical, Statistical and Experimental Engineering Research on Vented and Unvented Traps—By A. E. Hansen, Hydraulic and Sanitary Engineer, New York City: The Author, 2 Rector St. Cloth; 7 x 9 in.; illustrated.

In view of the vigorous discussion of the use of the so-called non-vented, anti-siphon or re-sealing trap, especially since the war, this book is certainly a timely publication. Beginning with the introduction of the first plumbing fixtures in Longfellow's home in Cambridge in 1840 and quoting from Waring, Gerhard, and other well known sanitary engineers, the author gives abstracts from modern plumbing regulations and lists of cities where unvented traps are permitted and where they are not permitted. He describes the tests of the "Geco" or Cody trap which were made by the New York City Board of Standards and Appeals in 1918 at the Hallenbeck Building; and then takes up in detail the experiments made by himself at 366 West Broadway, New York City. The results of these experiments are given in detail and illustrated by many graphs. In general it may be said that the experiments showed up the Geco trap in a very unfavorable light. The author says that he does not believe that any anti-siphon trap can be made without mechanical features, or without disproportionate size, which will effectively withstand back pressures. He emphasizes the unreliability of tests made with clean traps and stresses the need of fouling tests. In conclusion, he makes a brief statement on the economic side of the problem.

Engineers who are interested in pending developments affecting plumbing regulations will do well to familiarize themselves with the subjects treated in this book.

Engineering Construction Cost Keeping

CONSTRUCTION COST KEEPING AND MANAGEMENT: A Treatise for Engineers, Contractors and Superintendents Engaged in the Management of Engineering Construction—By Halbert Powers Gillette, M. Am. Soc. C. E., Editor *Engineering and Contracting*, and Richard T. Dana, M. Am. Soc. C. E., Consulting Engineer, Chief Engineer Construction Service Co., New York and London. McGraw-Hill Co. Cloth; 6 x 9 in.; pp. 572. $5.

In its first edition ("Cost Keeping and Management Engineering," reviewed in *Engineering News*, Feb. 17, 1910) this book was probably the earliest attempt to enunciate principles of management of construction operations; to describe cost-keeping methods; to set forth the vital distinction between cost keeping and bookkeeping, and to correlate management and cost keeping. No book has superseded it in its particular field. The present edition contains all that made the first edition unique and some additional matter, particularly on cost-keeping systems in general and on cost keeping for highway construction. The new material on highway cost keeping is important in view of the great increase in this field of construction in the decade since the first edition of this book was published.

At the beginning of the volume the laws of management are defined and explained. The authors formulate eleven of these major laws and consume 42 pp. in presenting them. There follows in a second chapter 18 rules for securing minimum costs. Systems of paying labor, as, for example, piece rate and bonus systems, and methods of measuring output are next considered. Cost-keeping methods, cost forms and cost diagrams are given in the remaining six chapters. Notable chapters are the one on highway cost keeping, previously mentioned, and one on bookkeeping for small contractors.

Metallography and Metal Structure

STRUCTURE AND RELATED PROPERTIES OF METALS—Circular 113, U. S. Bureau of Standards. Compiled by Henry S. Rawdon, Physicist. Paper; 10 x 7 in.; illustrated. Superintendent of Documents, Washington, D. C.

Publications of ephemeral character sometimes prove to have more definitely the treatise or textbook character than that of a bulletin. Of the recent examples of this among government publications, Bureau of Standards Circular 113 is noteworthy. It covers the field of metallography and the study of metal structure by etching and microscopic examination in so excellent a form (though in extreme condensation) as to entitle it to a place with the best available treatises.

A subject such as the one here dealt with can hardly be treated in elementary manner. Correspondingly, this "Circular" is not a primer. For a real understanding of its contents the reader requires a large amount of preliminary and additional information. Yet the work is so written that it can be read with profit by engineers of many pursuits who have need of dealing with problems of metal qualities or defects.

The introduction states that the work is not intended to displace or parallel existing treatises on metallography, but to show the value of metallographic examinations for the investigation of metals. It does this, however, not by giving instances of what problems have been solved by metallographic examination, but rather by setting forth in some detail the methods of metallography and the general facts of metal structure revealed by it. It thus presents an up-to-date outline sketch of the entire subject, which the reader desirous of going deeper into the subject can supplement by outside reading at various points where incompleteness is indicated.

The chief value of the work, we believe, as well as its main purpose, lies in presenting an impressive argument for the cultivation and use of metal examination in the study of engineering and metallurgical problems. While this purpose could have been carried out even more effectively by fuller citation of cases from laboratory and field practice (at the risk, however, of making the book more bulky), the publication is to be recommended unreservedly to engineers as an ably written and authoritative outline of a subject with which, in the next generation, every engineer will require to be acquainted.

Belated American Edition

HYDRAULICS AND ITS APPLICATION—By A. H. Gibson, D.Sc., M. Inst., C.E., M. Inst., Mech.E., F.R.S.E., Professor of Engineering in the University of St. Andrews, University College, Dundee. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 813; 399 line cuts and half tones. $6.

In 1912, or four years after the appearance of the first edition of this British book, an enlarged edition was prepared by the author. The present volume, which was printed in Great Britain, appears to contain nothing more recent than the 1912 edition, except the title page. The first edition was reviewed, on the whole quite favorably, by Gardner S. Williams in the Engineering Literature section of *Engineering News*, Nov. 12, 1908, p. 535. In the preface to the second or 1912 edition the

author states: The "book has been practically rewritten," with some omissions and re-arrangement and "considerable additions" to "almost every section, particularly those dealing with flow over weirs, through pipes, and in channels *** A chapter dealing with wave motion has been added."

British Water Supply in the War

WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914-19—Water Supply: (1) France; (2) Egypt and Palestine. Chatham, England: Secretary, Institution of Royal Engineers. Cloth; 7 x 10 in.; pp. 87 and 64; halftones, line drawings, pen sketches and folding maps. 25 and 8 shillings respectively.

Thanks to progressive improvements in the water-supply of the British Expeditionary Forces in France and Belgium, unprecedented concentration of troops became possible. How this was accomplished is told in the first of these volumes.

Besides the elaboration of the water-supply staff, as a part of the Royal Engineers field service, salient features of the water supply development were: "semi-permanent and extensive systems of water supply, with headworks and pipe lines"; mechanical transport; purification plants; well-sinking outfits. Some of the purification plants were mounted on barges. Wallace & Tiernan chlorination plants on motor trucks were used.

In Egypt and Palestine methods similar to those used in France were employed, with variations due to local conditions. The latter included some of the primeval means of raising water.

Each volume contains much detail both as to plant design and field operation, extensively illustrated by halftones, line drawings, folding maps and, in the volume on Egypt and Palestine, by a goodly number of rough but serviceable pen sketches.

Ship Loading and Dispatching

WHARF MANAGEMENT, Stevedoring and Storage—By Roy S. MacElwee, Director of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, and Thomas R. Taylor, Chief of the Latin-American Division, Bureau of Foreign and Domestic Commerce. Shipping Series New York and London: D. Appleton & Co. Cloth; 6 x 9 in.; pp. 350; 94 line cut and half tone illustrations. $5.

As the author's say in the preface: "This is the first effort to put between covers the vocation of loading and dispatching ships from the administrative standpoint." It is time that this highly important factor in marine operation had a text book and although the subject, and its text, are only of passing interest to the engineer, every engineer who has to design port terminals owes it to himself to get acquainted with the principles and practices the book describes.

Two Views of B. Welchii in Water

B. WELCHII AND THE MONTCLAIR WATER SUPPLY—By M. N. Baker, Associate Editor, *Engineering News-Record*; formerly President Montclair Board of Health. A Paper Read Before the New Jersey Sanitary Association, Montclair, N. J.: The Montclair Water Co. Paper; 6 x 9 in.; pp. 8.

BACILLUS WELCHII IN A PUBLIC WATER SUPPLY as a Possible Cause of Intestinal Disease—By Herbert B. Larner, S. B., Health Officer, Montclair, N. J. Reprinted from the *Journal* of the American Medical Association, Jan. 28, 1922. Address the Author. Paper; 6 x 9 in.; pp. 8.

The paper by Mr. Baker gives in much condensed form some of the statements and opinions published last year in *Engineering News-Record*, June 2 and 9 (symposium) and Sept. 22 (by Sir Alexander Houston) regarding B. Welchii in the Montclair water supply and that germ as a test for water and as a possible cause of water-borne intestinal troubles.

Mr. Larner presents the subject from his viewpoint of health officer of Montclair. He refers, without date, to the symposium in the *News-Record* of June 2 and 9 quoting in support of his argument 4 of the 66 contributors of the symposium, but making no mention of the 62 other contributors, most of whose testimony was against the B. Welchii theory. A broad-minded editorial in the issue of the *Journal* of the American Medical Association containing Mr. Larner's original article, takes into account both the symposium and Sir Alexander Houston's article. This editorial is not included in Mr. Larners's reprint but is well worth securing by those interested in the B. Welchii theory.

Memoirs of J. F. Wallace and Col. Webb

Portraits and brief memoirs of the late John F. Wallace and Col. George H. Webb appear in the February *Bulletin* of the American Railway Engineering Association (431 S. Dearborn St., Chicago).

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or, in case of books or papers privately printed, then to the author or other persons indicated.]

AN INVESTIGATION OF OXYACETYLENE AND CUTTING BLOWPIPES, with Especial Reference to Their Design, Safety, and Economy in Operation—By Robert S. Johnston, Engineer Physicist, Bureau of Standards. Washington, D. C.: Bureau of Standards. Paper; 7 x 10 in.; pp. 108; halftones and diagrams. Free while limited stock lasts; 35c. from Superintendent of Documents.

"Apparatus from 14 of the most prominent manufacturers were tested under standardized conditions." Methods and results are given.

ANSWERS TO PROBLEMS IN CONCRETE WORK, Volume I. by W. K. Hatt and W. C. Voss—New York: John Wiley & Sons. Paper; 5 x 7 in.; pp. 3. 25c.

AUSTRALIAN COMMONWEALTH RAILWAYS — Report, 1920-21. Melbourne: Commonwealth Railways Commission. Paper; 8 x 13 in.; pp. 41; folding maps and diagrams.

BETTER BUSINESS LIBRARIES: Talks with Executives—By Louise B. Krause, Librarian, H. M. Byllesby & Co., Chicago. Author of "The Business Library." Chicago: The Indexers Press. Cloth; 5 x 7 in.; pp. 98. $1.30.

Many valuable suggestions for the formation, arrangement and use of business libraries are given in this volume. The first two chapters deal with the why and the function of business libraries. The next one is a good plea for the employment of trained librarians. There are chapters on books, periodicals, indexes and digests of periodicals, financial and trade services, government publications (unfortunately confined to Federal Government only), library arrangement and putting business libraries to work. The book deserves the careful attention of all business houses that have or ought to have a good library.

BUILDING CODE, STATE OF WISCONSIN—Revision of 1921. Industrial Commission of Wisconsin, Madison, Wis. Paper; 6 x 9 in.; pp. 129.

CANADIAN RAILWAY STATISTICS, 1920—Ottawa, Ont.: Dominion Bureau of Statistics. Paper; 6 x 9 in.; pp. 308.

CHAPTERS ON THE HISTORY OF THE SOUTHERN PACIFIC —By Stuart Daggett, Ph.D., Professor of Railway Economics and Dean of the College of Commerce, University of California; Author of 'Railroad Reorganization." New York: The Ronald Press Co. Cloth; 6 x 9 in.; pp. 470; frontispiece. $5.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1920—Compiled by Statistical Division, Board of Engineers for Rivers and Harbors. From Report of Chief of Engineers, 1921. Washington, D. C. Paper; 6 x 9 in.; pp. 1434.

DEPARTMENT OF JAPANESE RAILWAYS—Report for 1919. Tokyo, Japan. Paper; 8 x 12 in.; pp. 116; map.

DEVELOPMENT OF THE WATER RESOURCES OF THE MAHONING RIVER Including Stream Control for Sanitary Purposes—Report to the City Council of Warren, Ohio, by Alexander Potter, Consulting Engineer, 50 Church St., New York City. Paper; 7 x 10 in.; pp. 148; illustrated with diagrams and maps, some on folding plates. $1, from the Author.

A plan for water supply, river sanitation and flood control for the benefit of Warren, Niles, and Youngstown. Has in view a Mahoning Valley Sanitary District, under state legislation of 1919. Plan includes large storage reservoirs, canal, etc. Rainfall, stream flow, etc., reviewed. Report was made in November, 1920, but just published.

ELEMENTS OF DIFFERENTIAL AND INTEGRAL CALCULUS WITH APPLICATIONS—By William S. Hall, E.M., C.E., M.S., Professor of Mathematics in Lafayette College. Second Edition, Revised. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 250.

The chapters on Definitions and First Principles, Differentials and Rates, and Integration have been completely rewritten. The first edition was published in 1897.

EYE CONSERVATION IN INDUSTRY—Part of the Study of Waste in Industry Conducted Under the Auspices of the Federated Engineering Societies. New York: Eye Sight Conservation League, Times Building. Paper; 6 x 9 in.; pp. 29.

FOREIGN TRADE MARKETS AND METHODS—By Clayton Sedgwick Cooper, Author of "Understanding South America," etc. New York and London: D. Appleton & Co. Cloth; 6 x 9 in.; pp. 440; illustrated.

A comprehensive treatment of the whole subject of foreign trade; where it is to be found, what it demands and what it offers. Not the least valuable feature is a 24-p. chapter on Literature and Study Course for Foreign Trade Representatives which includes a helpful bibliography. Altogether a worth-while and practical book.

A HALF CENTURY OF PUBLIC HEALTH: Jubilee Historical Volume of the American Public Health Association—In Commemoration of the Fiftieth Anniversary Celebration of Its Foundation, New York City, Nov. 14-18, 1921. Edited by Mazyck P. Ravenel, M.D., President. New York: American Public Health Association. Stiff paper; 7 x 10 in.; pp. 461; frontispiece portrait of Stephen Smith, M.D., Founder and First President of the Association. $3.75; cloth, $5.25.

HEATING AND VENTILATION—By the Late John R. Allen, M. Am. Soc. M. E., Director of Research Laboratory of American Society of Heating and Ventilating Engineers, formerly Dean of Engineering and Architecture, University of Minnesota; and J. H. Walker, Superintendent of Central Heating, the Detroit Edison Co., President National District Heating Association, 1922. Second Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 332; illustrated, $3.50.

The first edition of this book was favorably reviewed in these columns Oct. 17, 1918, p. 727, by D. D. Kimball. In the present edition, the preface states: "Several of the chapters have been entirely rewritten and a more logical arrangement has been adopted. The entire book has been thoroughly revised and slightly enlarged (about 65 pp. added). The aim has been to increase in every possible way its value as a college textbook, in which field it has been widely used."

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO—Report by William S. Murray on Government Owned and Controlled Compared with Privately Owned and Regulated Utilities in Canada and the United States. New York: National Electric Light Association. Paper; 8 x 11 in.; pp. 223; maps and diagrams.

The exact title of this pamphlet is given in quotation marks. The opening words in capital letters denote better the main topic of the report. Mr. Murray's conclusions are adverse to the success of the Canadian undertaking. A summary of the report appears on p. 453 of this issue.

INCOME TAX PROCEDURE, 1922—Including Federal Capital Stock Tax, Federal Estate Tax, and Supplement to Excess Profits Tax Procedure, 1921. By Robert H. Montgomery, C.P.A. New York: The Ronald Press Co. Cloth 6 x 9 in.; 1911. $10.

INDIAN RAILWAY BRIDGE COMMITTEE—Report of Fifth Meeting, Oct. 3-8, 1921. Chairman, G. Richards, Chief Engineer with the Railway Board, India. Paper; 8 x 13 in.; pp. 52; folding diagrams. 1 rupee, from Superintendent Government Printing, India, 8 Hastings St., Calcutta.

Besides details of meetings held on six days, contains various appendixes by members of the committee reporting and discussing bridge impact tests; also rules for design and inspection of railway bridges drafted in September, 1921, by Mr. Richards (title above) for submission to the Railway Board of India, and suggested amendment to the 1918 rules, with discussion thereon.

IRRIGATION 1919 AND 1920 UNITED STATES—Washington, D. C.: Bureau of the Census. Paper; 9 x 12 in.; pp. 38; two-page map in colors.

Contains irrigation statistics for 17 arid and semi-arid states. Most of the figures collected in 1920 are for the year 1919 and many corresponding figures for 1909 are given.

S HIGHWAY TRANSPORT AN AID TO THE RAILROADS?—By A. J. Brosseau, Member Board of Directors, National Automobile Chamber of Commerce. An Address before the Shipper's Conference of Greater New York. Reprinted from *Commercial Vehicle*, Jan. 15, 1922. New York: National Automobile Chamber of Commerce, 366 Madison Ave. Paper 6 x 9 in.; pp. 8.

LAND DRAINAGE—By W. L. Powers, M.S., M. Am. Soc. Agricultural Engrs., Chief in Soils, Oregon Agricultural College and Experimental Station, and T. A. H. Teeter, B. S., M. Am. Asso. of Engineers, formerly Professor of Drainage and Irrigation Engineering. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 9 x 6 in.; pp 270. Illustrated. $2.75.

MATERIALS OF CONSTRUCTION: THEIR MANUFACTURE AND PROPERTIES—By the Late Prof. Adelbert P. Mills, of Cornell University. Second Edition, Edited by Harrison W. Hayward, Professor of Materials of Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons, London: Chapman & Hall, Cloth; 6 x 9 in.; pp. 476; 192 illustrations. $4. 24s. net.

Some chapters have been added, some condensed, some rewritten in this edition. Acknowledgements are made to the following members of the M.I.T. Staff: For "reviewing" Steel, Prof. Henry Fay; Non-Ferrous Metals and Alloys, Prof. R. S. Williams; Stone and Timber, Prof. I. H. Cowdrey; new chapter on Mechanical Fabrics, Prof. G. B. Haven; rewriting Concrete, Dean Peabody, Jr. The first edition was reviewed in *Engineering Record*, June 26, 1915, and in *Engineering News*, July 15, 1915.

MINISTRY OF HEALTH REQUIREMENTS AS TO SEWAGE PURIFICATION, With Extracts from the Reports of the Royal Commission, and Other Engineering Data—By S. H. Adams, Assoc. M. Inst. C.E. London, England: St. Brides Press. Cloth: 6 x 9 in.; pp. 39; illustrated. 6s. net.

Contains very little specific information as to the "Requirements" but many notes and data that are presumably useful in preparing a scheme in accordance with the "Requirements."

MODERN TUNNELING—By David W. Brunton and John A. Davis. New Chapters on Railroad Tunneling by J. Vipond Davis. Second Edition. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 x 9 in.; pp. 612; 120 illustrations. $6.50. 39s. net.

NEW JERSEY WATER RESOURCES AND THEIR DEVELOPment—Report by Hazen, Whipple & Fuller, Civil Engineers, New York City. Trenton, N. J.; Department of Conservation and Development. Paper; 6 x 9 in.; pp. 76; illustrated. See abstract elsewhere in this issue.

NINE YEARS' OPERATION OF THE BALTIMORE SEWAGE WORKS—By Theodore C. Schaetzle, Principal Sanitary Chemist of Sewage Works, Baltimore, Md. Reprinted from *Engineering News-Record*, July 14 and 21, 1921, by the Highways Department of the City of Baltimore (August E. Christhilf, Highways Engineer; M. J. Ruark, Division Engineer of Sewers). Paper; 5 x 8 in.; pp. 33; illustrated.

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SANITATION AND SEWAGE DISPOSAL FOR FARMSTEADS AND COUNTRY ESTATES—By William Paul Gerhard, C.E., Dr. Eng., Consulting Engineer. New York City: The Author, 17 W. 42nd St. Paper; 6 x 9 in.; pp. 12. 30c.

SEWERAGE AND SEWAGE TREATMENT—By Harold E. Babbitt, M.S., Assoc.M. Am. Soc. C.E., Assistant Professor, Municipal and Sanitary Engineering, University of Illinois. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 x 9 in.; pp. 531; illustrated. $5. 30s. net.

SPECIAL ASSESSMENTS: Assessments for Benefits as a Means of financing Municipal Improvements—By the Committee on Sources of Revenue, National Municipal League. February issue of *National Municipal Review*, 261 Broadway, New York City.

STADTEBAU—Von Otto Blum, Dr.-Ing., ord. Professor an der Techn. Hochschule in Hanover, G. Schimpff, weil. ord. Professor an der Techn. Hochschule in Aachen, und W. Schmidt, Dr.-Ing., Stadtbauinspektor in Stettin. Handbibliothek fur Bauingenieure. Boards; 7 x 10 in.; pp. 478; 482 text illustrations. Berlin: Julius Springer. 78 marks.

STATE DEPARTMENT OF HEALTH OF NEW JERSEY—Report for 1920-21. Cloth; 6 x 9 in.; pp. 350.

STATISTICS OF CITIES AND TOWNS OF IOWA, 1919-20—Des Moines, Iowa: Frank Shaw, State Auditor. Paper; 6 x 9 in.; pp. 224.

ST. LAWRENCE WATERWAY—Message from the President of the United States (Jan. 16, 1922) Transmitting a letter from the Secretary of State Submitting the Report of the International Joint Commission Concerning the Improvement of the St. Lawrence River Between Montreal and Lake Ontario for Navigation and Power. Senate Document 114, 67th Congress, second session. Paper; 6 x 9 in.; pp. 184; folding plates.

STREAM GAGING RECORD CHART, NEW YORK STATE—In Appendices to 1920 Report, New York State Conservation Commission, Albany, N. Y.

TABLE FOR OBTAINING DIFFERENCES OF ELEVATION AND HORIZONTAL DISTANCES FROM VERTICAL ANGLES AND STADIA DISTANCES—Designed by Arthur Alvord Stiles, State Reclamation Department, Austin, Tex. Paper; 5 x 12 in.; p. 141. Free to those "having real need" for the table "as long as limited supply lasts," together with illustrated instructions for binding and for cutting the leaf margin index.

Gives "differences of elevation and horizontal distances for vertical angles and stadia distances." On each two facing pages the extreme left hand column gives observed stadia distances at intervals of 2.5 from 100 to 140 and of 5 from 140 to 535 and the extreme left hand column gives corresponding horizontal differences. The intermediate columns show differences of elevation corresponding to the vertical angles and observed stadia distances. The marginal indexes are cut to show degrees only but include minutes also.

TABLES AND DATA FOR ENGINEERS AND BUSINESS MEN—Compiled by Charles E. Ferris, B.S., Professor of Mechanical Engineering, University of Tennessee. 24th Edition. Knoxville, Tenn.: University Press. Flexible cover; 3 x 6 in.; pp. 229. 75c.

TENSILE PROPERTIES OF SOME STRUCTURAL ALLOY STEELS AT HIGH TEMPERATURES—By H. J. French, Physicist, Bureau of Standards, Washington, D.C. Paper; 7 x 10 in.; pp. 92. Free from Bureau of Standards while stock lasts; 5c from Superintendent of Documents.

UNITED STATES PUBLIC HEALTH SERVICE—Report for 1920-21. Cloth; 6 x 9 in.; pp. 429.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Highway Standards Prevented by Politics

Sir—The editorial in *Engineering News-Record*, Feb. 2, 1922, p. 177, under the caption "Activity on Highway Standards," is more or less an indictment of the highway engineers of the country for failure to change immediately conditions over which they do not have complete control.

We do not have to go far to find several reasons for the state of affairs criticised, but we must travel a long road to find and effectually apply a remedy.

During three years membership on the Executive Committee of the American Association of State Highway Officials, and as member of the special committee which conducted the initial negotiations with the Associated General Contractors, looking toward greater co-operation between the highway officials and contractors, I had opportunity to observe and study several phases of this question, which are not apparent to the casual observer.

A prerequisite to the establishment of proper relations between the contractor and highway engineer, is the adoption by all states, counties and municipalities, of standard proposal and contract forms; a general adoption of a sufficient but reasonable proposal and contract bond; a lower retained percentage on monthly payments to assist the contractor in financing his work; the engagement of intelligent, trained inspectors; and the placing of the chief engineer in absolute authority, back of which there is no recourse to political influence to secure acceptance of questionable work. Along with these, and no less important, is the general adoption of a specification, which for each standard type of pavement and method of procedure, shall be as near an approach to a common standard as the varying local conditions will permit.

Why have the American Association of State Highway Officials and the several county and municipal authorities been thus far unable to make effective the above requisites to a successful co-operation between the interested parties?

Some of the fault undoubtedly lies with the engineers, and to a certain extent past practices among certain contractors are responsbile, but in the main it lies in that old bugaboo, politics and political manipulation for partisan benefit. To this one factor may be traced most of the ills inherent in the conduct of our highway work.

Uncertain tenure of office, and removals of engineers with each changing administration prevent that continuity of effort so necessary to the upbuilding of any set of standards. It takes about two years for any newly appointed engineer thoroughly to acquaint himself with the needs of his state, and the methods and practices of his contemporaries; and just about the time he is ready and fitted to settle down to a constructive policy, along comes a new executive who makes changes which start the old cycle again on its weary round.

Another factor has in the past militated against development of "rational design," namely, lack of funds for research work, and lack of sympathy with it, not on the part of engineers, but on the part of the commissioners or governing bodies who control the engineer's activities. Engineers in states having no funds or facilities for research work must perforce await the results of such research in states where it is under way. They must then make the best possible application of them to their peculiarly local problems.

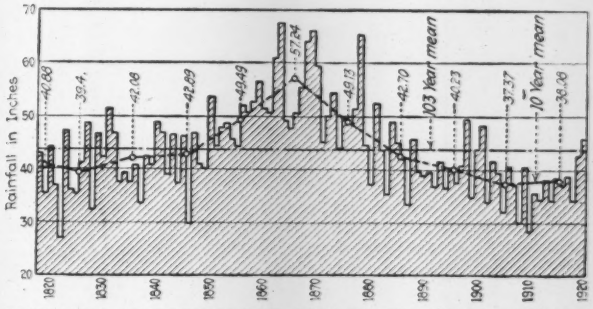
I have come to the conclusion that the fine research work being done by the Bureau of Public Roads by Clifford Older of Illinois, and several other states and institutions should serve as a guide in the future to all other states, since the conditions under which tests are conducted are fairly typical of conditions in the country as a whole, and that work done by others will only be a duplication of effort. Until the worth of the results of these tests have been proved by the only real proof, fairly long time service under any and all conditions, our engineers should not jump at preliminary conclusions and blindly follow a common standard.

Trenton, N. J. W. G. THOMPSON,
Feb. 8, 1922. Consulting Highway Engineer.

Rainfall at Norfolk Compared With Long-Term Records at Boston and Elsewhere

Sir—The continuous decrease in the rainfall at Norfolk, Va., during the past fifty years, to which attention has been called by Ellis B. Noyes (*Engineering News-Rerord*, Aug. 4, 1921), may possibly be a phase of a phenomenon of rather general character. On investigating the rainfall data which the writer has available, the surprising fact is brought out that there is a well marked maximum in the rainfall at stations in various parts of the United States, toward the end of the past century. The accompanying table shows the ten-year means for twelve cities, these particular records not being specially selected but being all the writer has at hand. Six show well marked maxima in the decade 1871-1880 inclusive, two in the preceding decade and three in the following.

The diagram showing the annual rainfall at Boston, Mass., is interesting in this connection, as it indicates that, at Boston at least, the steady decrease during the past fifty years has been merely the down-swing from the maximum that had been gradually approached during the preceding forty or fifty years.



RAINFALL AT BOSTON FOR THE 103 YEARS, 1818 TO 1920

AVERAGE RAINFALL PER DECADE IN 12 AMERICAN CITIES

The maxima are shown in italics. There are six of these in the decade, 1871-80.

Years	New Bedford, Mass.	Boston, Mass.	St. Paul, Minn.	St. Louis, Mo.	San Diego, Cal.	San Francisco, Cal.	Portland, Ore.	Cincinnati, Ohio	Washington, D. C.	Denver, Colo.	Salt Lake City, Utah	Norfolk, Va.
1811–1820	35.56	40.88										
1821–1830	*51.95*	39.41										
1831–1840	45.96	42.08	24.03	36.90								
1841–1850	44.94	42.89	27.38	45.34								
1851–1860	44.76	49.49	25.69	*45.73*	8.87	22.22						
1861–1870	46.27	*57.24*	28.88	40.76	9.22	*25.09*						
1871–1880	46.88	49.13	*29.85*	37.13	9.58	24.32	*53.19*	*48.37*	42.26	*14.67*	*17.52*	*53.41*
1881–1890	48.69	42.70	25.54	39.85	*11.76*	24.60	45.75	40.49	47.07	13.89	15.73	52.00
1891–1900	47.91	40.23	28.27	36.12	7.82	19.51	39.16	35.01	39.58	14.10	15.49	47.40
1901–1910	45.82	37.37	29.02	35.52	10.14	20.72	41.02	34.27	43.19	14.41	16.49	41.94
1911–1920	42.00	38.08	27.58	37.93	10.28	20.83	39.57	39.39	44.17	14.52	16.35	37.40

In general, a more or less continuous decrease from a maximum is shown by the other long records and it seems reasonable to think that if the record of rainfall at Norfolk extended back for about one hundred years it might show the same marked maximum as at Boston.

Foo Chow, China, Dec. 16. J. R. WEST,
Engineer-in-Chief, Min River Conservancy

NEWS OF THE WEEK

New York, March 16, 1922

Motor Vehicle Registration Shows Increase

Preliminary Returns for 1921 Indicate a Total of 10,325,000 Cars and Trucks

The U. S. Bureau of Public Roads reports that the motor vehicle registration for the year 1921 will total approximately 10,325,000, returns having been received from all states except Virginia, Arizona, and California, for which estimates were made on the basis of the other returns. This represents an increase of more than a million vehicles over the 1920 figure, or an amount equal to the total number at the beginning of 1913. The greatest increases in registration were in industrial sections, the agricultural sections in general showing a smaller amount of increase. No state reported a registration less than the 1920 figure. The total amount collected as fees amounted to about $125,000,000.

It had been anticipated that the 1921 registrations would show a falling off in the rate of increase, but the figures reported indicate that such is not the case. The increase continues approximately at the same rate that has been maintained for the past seven years and shows no indication of the near approach of a condition of saturation in the supply of motor vehicles.

The recent Federal Highway Act provided for the construction of a connected system of highways consisting of not more than 7 per cent of the roads in each state and made an initial appropriation of $75,000,000 to be used in conjunction with state funds. The system to be built is now being outlined and will comprise about 180,000 miles of road, included in which are about 60,000 miles already completed.

With an annual program based on a federal appropriation of $75,000,000 and assuming that the states will continue to match the federal funds in the same ratio as heretofore and that the average costs of the roads built will be $20,000 per mile it will take 15 years, the Bureau of Public Roads estimates, to complete the proposed system. If the federal appropriations are made at the rate of $100,000,000 a year the system can be completed in 10 years, and if only $50,000,000 are appropriated annually it will take 20 years to build it.

Goethals To Report on Columbia Basin Irrigation Project

Major-Gen. George W. Goethals recently completed a month's examination of the field work and studies prepared by the state of Washington in connection with the Columbia Basin irrigation project, referred to in this journal March 2, p. 372. Gen. Goethals is to report to the State of Washington some time in April, giving his findings upon the relative desirability of the two sources of water supply and his opinion on the feasibility of the whole plan.

Award 168-Mile Concrete Road Contract

A contract for the 168 miles of pavement in Maricopa County, Ariz., bids on which were noted in Engineering News-Record March 2, 1922, p. 372, was awarded to Twohy Bros., the lowest bidder. Concrete will be used for 160 of the 168 miles, the remaining 8 miles being classed in the specifications as "special pavement."

A total of about 1,600,000 sq.yd. of concrete will be laid in widths of 16 and 18 ft. Decision has not been made as to whether the thickness will be 5 or 6 in. A considerable portion of the system, however, will be 6 in. thick at the center with a 9-in. "inverted curb" on either edge of the slab.

Cut Funds for Topographic Mapping

Despite a determined effort on the floor of the House to increase the appropriation for the topographic mapping work of the U. S. Geological Survey, an amendment increasing the amount to $425,000, offered by Representative Hayden, of Arizona, was voted down. This leaves the item at $275,000 in the Interior Department bill which later was passed by the House. It is believed some increase will be allowed by the Senate.

The President and the Director of the Budget recommended an appropriation of $430,000 for the topographic work. The amount allowed for the current fiscal year was $330,000. Had Mr. Hayden's amendment been adopted, it simply would have restored the expenditure for topographic mapping to the pre-war rate.

Calls Conference on Business Training for Engineers

A second public conference on business training for the engineer and engineering training for the student of business has been called by the U. S. Commissioner of Education for May 1 and 2 at the Carnegie Institute of Technology, Pittsburgh.

Invitations to appoint delegates to the conference will be sent by the commissioner to commercial, technical and educational institutions as well as to prominent individuals. "It is planned to have the second conference," says Dr. Glen Levin Swiggett of the Bureau of Education, "even more constructive than the first, since which time the curricula of 29 of the 119 engineering colleges reporting to the Bureau of Education have been favorably modified to include one or more of the four committee recommendations." The first conference was held in June, 1919, at Washington.

Bill Would Oust New Jersey Tunnel Commissioners

The New Jersey Assembly this week is expected to enact, over the predicted veto of the governor the bill, already passed, ousting the present membership of the New Jersey Interstate Bridge and Tunnel Commission and naming a new group of commissioners to administer the Hudson River vehicle tunnel and the Delaware River bridge projects. The so-called "ripper bill" would remove from office T. Albeus Adams, chairman of the commission, Samuel Shay, Charles S. Stevens and Frank F. Gallagher.

If the bill becomes a law the new commission would consist of four Republicans and four Democrats, as follows: Republicans, Weller H. Noyes, Tenafly; T. J. S. Barlow, Maple Shade; John B. Kates, Collingswood; Theodore Boettger, Hackensack. Democrats, Robert S. Sinclair, South Orange; Isaac B. Ferris, Merchantville; John F. Boyle, Jersey City, and Frank L. Supplee, Glassboro.

Broken Narrows Siphon Repaired and Placed in Service

The repair of the Narrows siphon, the 36-in. flexible joint cast-iron pipe line carrying water from Brooklyn to Staten Island, New York City, which was broken by a dredge spud Feb. 2 was completed last week and service was resumed. The unusual repair methods were described in this journal March 2, p. 346, by W. W. Brush.

The line was first blown out and then tested for leakage under 35 lb. of air pressure. Bubbles were observed escaping from only one of the 1-in. bolt holes of the special cast-steel sleeve at the repaired joint and this bolt was replaced after which the air leakage was negligible.

Chlorinated water, dosed with 2 p.p.m., was then turned in to the line and allowed to flow to waste for 7 hours before the discharge was delivered to the Staten Island distribution system. At the end of this period tests showed no B. coli in 100-cu.cm. samples and a total bacterial count of only 6.

The repair work, performed by the Merritt & Chapman Derrick and Wrecking Co., cost approximately $55,000.

Bills Seek Change in New York License Law

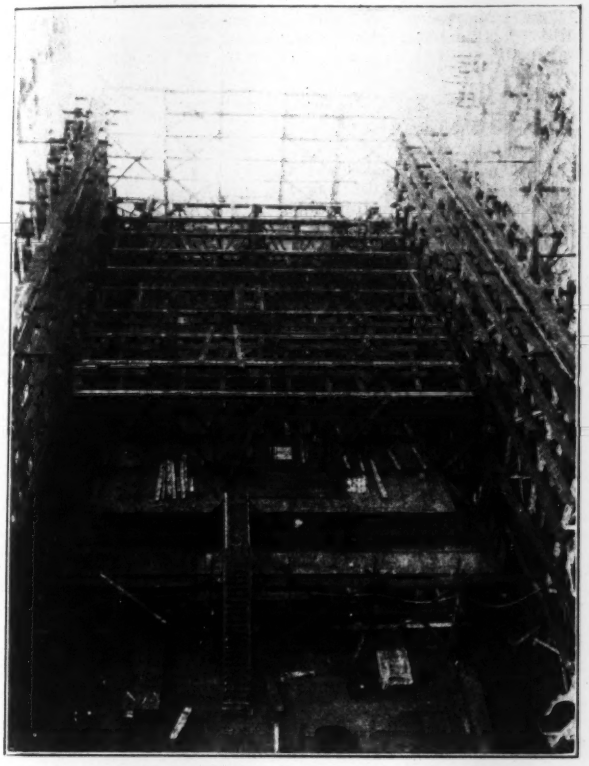
Several bills amending the existing engineer license law in New York State have been introduced in the Assembly at Albany, the purpose of which, according to a recent statement by the New York Chapter of the American Association of Engineers, is to protect politically-controlled county supervisors who, under existing conditions, have jurisdiction over highways, bridges, culverts, and other public works requiring engineering skill. The bills in question are said to be an attempt to exclude engineers engaged in public works from the provisions of the license law.

$2,500,000 Asked To Fight Teredo

President Harding on March 9 asked Congress to include in the Navy bill for next year a supplemental appropriation of $2,450,000 for use in counteracting the damage caused by the teredo at the Mare Island Navy Yard in San Francisco Bay. The destructive effect of marine borers in these waters has been frequently noted in these columns in the past year and a half. The situation at Mare Island has become most serious and requires immediate remedy.

Large Bridge-Pier Caissons Being Built at Shipyard

Work is in progress in the yard of the New York Shipbuilding Co. at Camden, N. J., on the construction of the two great pier-foundation caissons for the Delaware River bridge, to connect Philadelphia and Camden. The shipbuilding company is sub-contractor for this part of the work, Holbrook, Cabot & Rollins and the Keystone State Construction Co., associated, being the contractors for the piers. Both caissons are being built in regular shipbuilding berths, occupied at other times by warships. One of them, Caisson A, is shown in an early stage of construction in the picture herewith.



BUILDING PIER CAISSONS FOR THE DELAWARE RIVER BRIDGE IN A SHIPYARD

Caisson A is shown in the view. It is on one of the large shipways of the New York Shipbuilding Co. at Camden, N. J., alongside a Japanese warship. These ways are roofed over, permitting work to go on unhindered by the weather.

Each of the two caissons is 70 ft. x 143 ft. in outside dimensions and comprises a steel working chamber about 8½ ft. high surmounted by steel trusses about 15 ft. deep, both longitudinal and transverse. The shell of the caisson above the working chamber will be built of timber. The total height of the caisson proper will be about 40 ft., but the first caisson will be built up at the shipyard after launching with about 25 ft. of cofferdam on top of the caisson.

Heavy timber bulkheads divide the working chamber into five compartments. The four bulkheads, each 36 in. thick, are shown in the view, in place on the ways, ready for the setting of the cutting edge, steel and roof plating of the working chamber. It is expected that these bulkheads will be of service in controlling the sinking of the caissons. To protect them against damage in launching a loose bottom will be placed under the caisson, to be removed as soon as the structure has entered the water. The first of the caissons will probably be launched within the current month.

Havana Port Work To Start Soon

The Parklap Construction Corp. of New York City, expects to commence work soon on the docks and piers for the Port of Havana Docks Co., Havana, Cuba. The piling and foundation work has been sublet to the Raymond Concrete Pile Co. and the reinforced concrete superstructure to the Turner Construction Co., both of New York City. Other subcontracts will be awarded shortly.

The port work is part of a general improvement originally contracted for several years ago, but which has been deferred through various causes. About $2,000,000 is involved in the immediate outlay, and a reinforced-concrete pier, pier shed and a shore reinforced-concrete warehouse are the main structures. The pier will be 580 ft. long and 210 ft. wide at the deck level. The shore warehouse will be of three or four stories in height, and 450 ft. long and 65 ft. wide.

Few Colorado Engineers Are Without Employment

Only 4 per cent of the membership of the Colorado Society of Engineers are registered as seeking employment, according to the January *Official Bulletin*. This does not mean that they are actually out of work for many men seek constantly to better their positions. However, non-member applicants, while more numerous than a year ago, are steadily finding desirable positions through the free agency maintained by the society.

Jurisdiction Award Action Approved by F.A.E.S.

Executive Board of American Engineering Council Holds Meeting in Chicago March 10.

Confirmation of the action of the National Board for Jurisdictional Awards in its efforts to bring the carpenters' union to accept the board's decisions in building controversies was given by the executive board of the American Engineering Council at the meeting March 10, in Chicago. Members of the Federated American Engineering Societies were urged to insert in all specifications and contracts a stipulation that the decisions of the Jurisdictional Board shall be observed. With the exception of the carpenter's union the other sixteen international unions have supported actively the findings of the board.

Report was made of the passage of federal legislation to reform the U. S. Patent office, the successful outcome of which is attributed largely to the efforts of the federation.

World Organization Discussed

World engineering organization to promote international peace was discussed and a committee was authorized to consider the various phases of the question, together with possible constitutional changes should the Engineering Institute of Canada make application for membership.

The Sterling reclassification bill was endorsed rather than the Lehlbach bill, since the salary schedules on the former are approximately 10 per cent higher than in the latter and conform more nearly with the report of the original reclassification committee's report.

Employment service, which the committee on that subject believes should be turned back to the jurisdiction of the constituent societies, retains its *status quo*, with a new committee authorized to bring in a new report. It was intimated that possibly some working arrangement might be made with the American Association of Engineers. The existing committee states in its report that the fundamental object of the F. A. E. S. is the rendering of service to the public where engineering problems are involved, while employment service is essentially personal, the direct personal contact of the engineer being with the constituent societies.

A report on the publication of a bulletin by the society was laid on the table and later taken therefrom and the committee asked to bring in information on proposals by a private publisher. Among several subjects laid on the table were the consideration of the Muscle Shoals project, the utilitarian use of national parks, tariff on technical books, the proposed Great Lakes-St. Lawrence waterway and participation in an international engineering congress.

The recommendations of the Conference on Standardization of Paving Brick were approved. A committee was authorized to look into the question of an international standard rating system which Richard Bolton has invented to see whether it is anything F. A. E. S. should consider. The question of basic wage rates, brought up by the American Society of Mechanical Engineers, was referred to a committee.

The financial outlook of the federation for 1922 is much brighter than it appeared at the time of the meeting of the council in January.

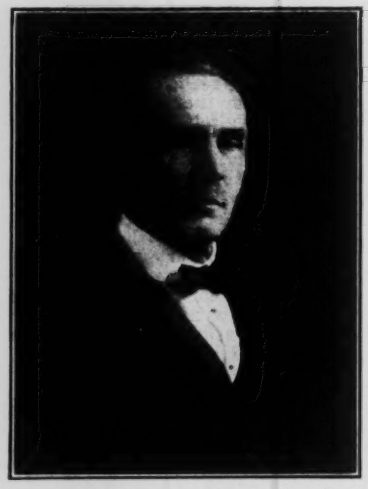
J. L. Campbell New Head of Railway Engineers

Is Chief Engineer of the El Paso and Southwestern Railway System—Member 15 Years

John Logan Campbell, chief engineer of the El Paso & Southwestern Ry. System, who was elected president of the American Railway Engineering Association at its Chicago meeting March 14-16, was born in 1863. His education was received in the public schools, at Ewing College, Ill., and at the Normal University, Lebanon, Ohio, after which he taught school for three years. In 1888, he went to the southwest, entered engineering work in land and mining surveying as deputy county surveyor of El Paso County, Tex.

Mr. Campbell entered railway work in 1894 as resident engineer on construction of the Rio Grande Northern R.R. He was chief engineer of the Rio Grande Dam & Irrigation Co. projects (the predecessor of the Rio Grande project of the U. S. Reclamation Service) from 1894 to 1898, during part of which time he was also locating engineer for the Rio Grande, Sierra Madre & Pacific Ry. and chief engineer of location and construction of the El Paso & Northeastern Ry. (now the Eastern division of the El Paso & Southwestern.

Elected President A. R. E. A.



John Logan Campbell

After being locating engineer for the Atchison, Topeka & Santa Fe Ry. in 1899 and 1900, he was engineer in charge of relocation and reconstruction of the Arizona & New Mexico Ry. during its change from narrow- to standard-gage in 1900 and 1901. From 1901 to 1905 he was chief engineer of location and construction of the St. Louis, Kansas City & Colorado. R.R. (now the St. Louis-Kansas City line of the Rock Island System). From 1905 to 1920, as engineer maintenance of way, he was in charge of location, construction and maintenance of the El Paso & Southwestern System. Since 1920 he has been chief engineer of the road.

He became a member of the American Society of Civil Engineers in 1901, and of the American Railway Engineering Association in 1906.

Group Conferences on Design Begun by Am. Soc. C. E.

A series of three sub-section group conferences on design, the result of a questionnaire sent to members in regard to technical subsection meetings, was begun March 15 by the New York Section of the American Society of Civil Engineers. The plan provides for group meetings on the afternoons of three meetings of the section, the first preceding the joint meeting on the Port of New York. James H. Edwards, assistant chief engineer, American Bridge Co., presided and introduced for discussion the topic "The Importance of the Design of Details as Evidenced by Recent Theater Failures."

Call for Bids on Hetch Hetchy Power-House Equipment

San Francisco city officials have issued a call for bids, to be opened April 12, covering the generating equipment for the Moccasin Creek power house on the Hetch Hetchy project. Decision has not yet been made as to whether the city will sell this power in bulk or will use it only for its own needs. For this reason alternative bids are asked for. If the power is to be sold wholesale the full capacity of the plant will be installed; if not, the probability is that the first installation will consist of only two units.

The specifications for the water wheels call for bids on two, three or four units of 25,000 hp. capacity each. The hydraulic valves in the penstock just outside the power house are covered by separate specifications. Specifications for the electrical equipment call for two, three or four generator units, exciters and a spare exciter, each unit to have a capacity of 20,000 kva. The city is now building a 1½-mi. spur from the Hetch Hetchy railroad to give rail access to the new power house site.

The continuous flow from the Hetch Hetchy source of supply is considered sufficient for 60,000 hp. under the 1,300-ft. head at the Moccasin Creek plant but with the forebay reservoir capacity equal to about two and a half days flow through the 600 sec.-ft. aqueduct, it is considered economical to install a total of 100,000 hp. if this amount of power can be sold wholesale.

Power Company Wins in Suit Over Eel River Dam Contract

The Superior Court of California has rendered a decision in favor of the Snow Mountain Water & Power Co. and against W. A. Kraner, contractor, in the suit over the contract for the construction of a dam on Eel River, about 35 miles from Ukiah. Work on the dam was stopped last June when the structure was nearing completion. The contractor charged breach of contract and the company claimed the contract had been abandoned. The suit involved $743,000 and has been under way here for several months. A number of well known engineers were retained as expert witnesses by both sides.

Articles descriptive of the design and construction of the dam appeared in *Engineering News-Record*, May 5, 1921, p. 750 and p. 752. Work on the dam has recently been carried to completion by Stone & Webster, to whom a contract was awarded after the lawsuit with the former contractor began.

Unemployment Small in Ranks of American Association

Two and one-half per cent of the members of the American Association of Engineers are looking for positions according to the records of the employment department. Many of these hold temporary positions, so that the actual number unemployed is below 2 per cent. Apparently the worst of the unemployment period has been past. A survey made by the employment department covering 200 widely-separated localities indicates that there is a continued improvement in fundamental conditions of engineering employment. The spring construction season is nearly here, with many million-dollar construction projects either under way or ready to start. Not much railroad work is anticipated and the big demand for railroad engineers in the past will probably never again exist. The many states with substantial highway programs offer opportunities for engineers. The following table shows the trend of employment:

	Feb. 1922	Jan. 1922	Feb. 1921
Applicants for employment..	1,968	1,872	2,303
Positions received.....	312	323	558
Men referred.....	1,475	1,428	3,535
Men Placed.....	172	156	286

The average monthly salary of positions filled in February was $186; for the same month last year the average salary was $195. The highest salaried position filled during February was $8,000 per annum. The lowest salary was $110 a month. The greatest demand for engineers at this time exists in the South Atlantic states and the Central West. Demand exceeds supply in the case of architectural engineers and draftsmen and structural engineers who are specialists on buildings. Salaries for men in this field are increasing. The employment of mechanical and electrical engineers depends considerably on the industries which have been going through a period of depression and readjustment. The association officials in charge of employment state that engineering employment, after the long period of depression, is well on the way toward a normal condition.

Bill Fixes Higher Fees for Motor Trucks in New York

Increases in the registration fees for motor trucks are provided for in a bill introduced in the New York Senate Feb. 20 by Senator Seymour Lowman, chairman of the committee on internal affairs. For a truck whose gross weight exceeds 10 tons a license fee of $150 is proposed, as compared with a fee of $55 for a truck weighing between 10 and 11 tons under the provisions of the existing act. The license fees proposed in the new bill and those now operative are given in the accompanying table:

PROPOSED MOTOR-TRUCK FEES IN NEW YORK STATE

Gross Weight, Tons	Proposed Fee	Present Fee	Increase
2	$15	$10	$5
> 2 — 3	20	15	5
> 3 — 4	25	20	5
> 4 — 5	30	25	5
> 5 — 6	50	30	10
> 6 — 7	60	35	25
> 7 — 8	75	40	35
> 8 — 10	100	45–50	50
> 10	150	55+*	95

> Greater than.

* Increase in fee beyond this point is $5 per ton up to $70 for 14-ton gross weight, and then $10 additional for each ton over 14.

Detroit Studies Action of Tires on Asphalt Pavement

The city of Detroit, Mich., is engaged on a research program to determine the distribution of motor truck loads on asphalt pavements by various types of tire, the degree of resilience obtainable and the tractive resistances for various types of pavements. The work which is in charge of J. A. McCabe, research engineer, is preliminary to a decision regarding the installation of a motor-bus service in connection with the street railways.

Arthur St. Laurent Chief Engineer of Canadian Public Works

Arthur St. Laurent, recently appointed chief engineer of the Department of Public Works of Canada, has been in the service of the department since 1888, three years after his graduation from the Ecole Polytechnique, Montreal.

He was assistant engineer in the district office at Winnipeg for ten years, after which he was entrusted with the construction of a bridge over the Saskatchewan river at Edmonton, at a point where the current was particularly swift. In the face of considerable opposition Mr. St. Laurent constructed the bridge piers of concrete, which subsequently justified his judgment by standing against a spring flood which swept away all the ordinary structures in the valley.

At a later date he designed the locks and dam at St. Andrews in the Red River, near Winnipeg, and constructed the Laurier Avenue Bridge at Ottawa and the government grain elevator at Montreal. In 1908 he was appointed Assistant Deputy Minister of Public Works.

Plans Submitted for Ideal Section of Lincoln Highway

Plans have been received by the U. S. Bureau of Public Roads for the Ideal Section of the Lincoln Highway in Lake County, Indiana, during the coming summer. This section is to be a federal-aid highway. The plans submitted by the Indiana State Highway Department show that the section will be nearly 1⅞ miles in length and will be placed in the middle of a 100-ft. right of way. The roadway is to be 40 ft. wide and provision is made for the use of concrete, bituminous concrete or brick sections with 5-ft. gravel shoulders on each side and is of a thickness calculated to withstand heavy traffic.

Night travel will be made safer by electric lights 35 ft. above the roadway and at suitable intervals on one side of the road. All electric wires will be buried beneath the ground. For pedestrian travel a 5-ft. gravel sidewalk will be placed in one of the 25-ft. strips of parking which are to be on each side of the road and the parking will receive effective landscape treatment.

It is not thought that present traffic justifies the width of roadway to be built but rather it is intended as an object lesson for the future and the traffic studies to be made on it will aid in settling such questions as whether two roads some distance apart can serve traffic better than a single wide road, the best methods of traffic regulation and other questions which are becoming more important each year.

Federal aid will be granted on this highway at the rate of $20,000 per mile.

U. S. Commerce Chamber Did Not Announce New Air-Ship Line

Word has been received from the Chamber of Commerce of the United States that a widely circulated report that the Chamber had announced the formation of the new General Air Service was in error. The Chamber had nothing to do with this announcement, which was noted in *Engineering News-Record* of March 2.

City Management Class in Chicago A.A.E.

Among the self-help classes of the Chicago Chapter of the American Association of Engineers is one on city management, with about a dozen lectures. The subjects of this course have included municipal organization, the problems of city managers and aldermen, the preparation of budgets and estimates, and an outline of city government. Two lectures on the budget system are to be given March 17 and 24 by John A. Richert, chairman of the city finance committee of the city council.

Building of Public Schools Opens Construction in Pittsburgh

With school buildings costing $3,000,000 under construction in four sections of the city, and plans being laid for the erection of additional buildings, for which $3,000,000 in bonds have been sold, an impetus has been given to construction operations in Pittsburgh. It is expected that three of the buildings now under construction will be ready for occupancy for the new term of school. Immediately upon the acceptance of building plans for the additional schools by the Board of Education, the second group, involving $3,000,000 will be started.

The awarding of the general contract for a three-story building for the Mellon National Bank, which will cost approximately $3,000,000, has also been announced; the contractor is the Mellon-Stuart Co. of Pittsburgh. Foundations were completed a few months ago by the Hughes Foulkrod Co. of Pittsburgh at a cost of $300,000.

Business Cycles to Be Subject of Exhaustive Study

Representatives of various trade associations of the United States will meet in Washington on March 21 with members of the United States Chamber of Commerce, the Department of Commerce and the committee of the President's Conference on Unemployment, which is to undertake an exhaustive study of business depressions and with a view to mitigating this evil. Research bodies and private individuals have contributed $50,000 to make this study, which the conference expects to complete within six months. Wesley C. Mitchell, of the National Bureau of Economic Research, New York City, has been made field director of the survey and Edward Eyre Hunt, of the President's Conference, has been named secretary. A tentative plan for the study of unemployment and methods for controlling the business cycle has already been submitted to the Committee by Mr. Mitchell. It includes an exhaustive inquiry into methods of stabilizing industry.

Cheyenne Elects Engineer as City Commissioner

Cheyenne, Wyo. having the commission form of government, elected on a progressive ticket last November, H. A. True, Jr., a civil engineer, who on Jan. 1 took office as one of its three city commissioners. It is expected that Mr. True will handle the department of streets and possibly water, the city having a municipal water system.

Mr. True is 38 years old, a graduate of the University of Wisconsin, an associate member of the American Society of Civil Engineers and a member of the Wyoming State Society of Civil Engineers. Since graduation his engineering experience has included service with the U. S. Reclamation Service in Colorado and Nebraska; the Spanish-American Iron Co., Cuba, where he also assisted in railroad and harbor engineering; the Central Colorado Power Co., Colorado; the United Sugar and Land Co., Kansas, making relocation of canals, surveys of water supply, designing and installation of pumping systems and power plants; and the Field, Fellows & Hinderlider Engineering Co., of Denver, Colo., where he had charge of parties making investigation surveys for large irrigation projects in Wyoming, New Mexico and Colorado.

Since 1911 Mr. True has lived almost continually in Wyoming. He was for two years assistant state engineer, and was later put at the head of the Carey Act Department of the Wyoming State Land Office.

Norfolk To Begin $5,000,000 Port Development Project

By a majority of nearly 6 to 1 the voters of Norfolk, Va. on Feb. 7 authorized the city government to proceed with the issuance of $5,000,000 worth of bonds for port development. The bonds will be issued as soon as all requirements of the law have been complied with, and bids on the work will be asked for within the next two months, the plans having been already perfected. Preliminary work consisting of soundings etc. will be started at once.

The money, as outlined and estimated by the engineers of the port commission, will be used as follows:

Pier and transit sheds	$2,325,000
Bulkhead wharf	455,000
Grain elevator	648,000
Dredging and filling	256,000
Railroad tracks	122,000
Construction of pile breakwater	15,000
Surplus in reserve for contingencies	1,179,000
	$5,000,000

Record Fire Loss in 1921

The National Fire Protection Association has just issued a bulletin stating that the fire loss in the United States for 1921 exceeded that of any previous year. While final figures are not available, the total will be $500,000,000.

W. D. Pence Returns to Consulting Practice

William D. Pence, Chicago, has returned to consulting practice after seven years as engineer for the Wisconsin Railroad and Tax Commissions and eight years as a member of the engineering board of the Bureau of Valuation, Interstate Commerce Commission. He has opened an office at 8 So. Dearborn St., Chicago, and will give attention particularly to railway and public utility matters.

Mid-West Cement Makers Indicted

Twenty-six cement manufacturing companies of the Middle West, and forty-eight of their officers, have been made defendants in an indictment returned by a federal grand jury in Chicago March 8 but not made public until a few days ago. The defendant companies have an annual output of about 25,000,000 bbl. All are members of the Midwest Cement Credit and Industrial Bureau, also named in the indictment. There are eight counts in the indictment, charging combination in restraint of trade, conspiracy and a violation of the Sherman anti-trust law.

House Committee Reports River and Harbor Appropriations

The army appropriation bill as reported to the House by its appropriations committee recommends $27,635,260 for river and harbor improvements and $325,000 for surveys of rivers and harbors, including the proposed Miami and Erie canal.

For the Engineer Corps of the army $372,500 is recommended, which is $125,000 less than for the current year. The estimate includes the following: engineer depots $110,000, decrease of $90,000 from current year; engineer school $35,000, decrease of $10,000; engineer equipment of troops $75,000, decrease of $700,000; civilian assistants to engineer officers $40,000, no change; engineer operations in the field $85,000, decrease $135,000; military surveys and maps $25,000, no change; construction engineer wharf at Fort Mills, Philippines, $15,000, increase $12,000; construction of roads, bridges and trails in Alaska, $425,000.

Vogelson Chief of Philadelphia Bureau of Surveys

John A. Vogelson, since 1910 chief of the Bureau of Health of Philadelphia, became chief of the Bureau of Surveys in the same city on March 15, at a salary of $8,000 a year, filling the vacancy that has existed since George S. Webster resigned more than a year ago to become a member of the Delaware River Bridge Commission. Mr. Vogelson has been in the employ of the City of Philadelphia since 1901 except for brief periods while serving as principal assistant engineer of the department of water works and sewer construction at Manila, P. I., in 1905-6, and as assistant engineer on filtration with the New York City Department of Water Supply.

His Philadelphia work prior to becoming chief of the Bureau of Health in 1910 was all connected with the design, construction or operation of the various water filtration plants of that city. Before entering Cornell in 1897 (C. E., 1900), among other engagements dating from 1892, he was associated for a time with J. B. Lippincott at Los Angeles.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Spring Society Meeting, Dayton, Ohio, April 5-6; Subject, "Flood Problems."

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 9-11.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

The Building Officials' Conference will be held in Indianapolis, Ind. April 25-28 inclusive.

The Harvard Engineering Society will hold its regular monthly meeting at the Harvard Club, New York City, March 24. W. L. Hamilton will give an illustrated talk on the technique of aerial photography.

The Association of Professional Engineers of New Brunswick held its annual meeting at St. John, Jan. 27, electing E. B. Wass, president; C. C. Kirby, vice-president; and J. A. Waring, secretary.

The Illinois Scetion, American Water Works Association, will meet at Urbana, Ill., March 29 and 30.

The General Contractors' Association, New Orleans, La., elected the following officers at its annual meeting Jan. 31: President, A. M. Fromherz; vice-president, Lionel F. Favret; treasurer, John Reiss; secretary, J. M. de Fraites; assistant secretary, D. M. Hollingsworth.

The Engineers Club of Minneapolis elected the following officers at its recent annual meeting: President, Walter H. Wheeler; vice-president, W. T. Ryan; treasurer, O. F. Moore; secretary, Arthur F. Mellen.

The Wisconsin Engineering Society at its annual meeting held Feb. 24-25, elected the following officers: President, J. Donohue; vice-president, John C. White; secretary, Prof. L. S. Smith.

The Canton (Ohio) Engineering Society, has elected as president, E. J. Landor, engineer and contractor.

Personal Notes

WILLARD B. JONES has been temporarily appointed assistant structural engineer in the Water Department, Baltimore, Md.

W. E. SHEDDAN, former assistant City engineer of Jacksonville, Fla., has been appointed city engineer succeeding F. M. EDWARDS, resigned.

GEORGE MATTIS, formerly engineer for the California Railroad Commission and superintendent of streets of Oakland, Cal., has been appointed as one of the engineers to survey and value the property of the San Francisco-Oakland Terminal Railways.

CHARLES A. BROWNE, state highway engineer of Florida, has been appointed engineer for Orange County, Fla., to supervise the expenditure of $2,250,000 which the county has voted for road expansion. WILLIAM F. COCKE, formerly state highway commissioner, has been appointed to succeed Mr. Browne as state highway engineer.

IVAN E. GOODNER, for the past year chief engineer of the Columbia Basin irrigation project, has been appointed chief engineer of the Washington State Department of Conservation and Development with offices in the State Capitol at Olympia. In his new position he will supervise not only the Columbia Basin project, but all the state reclamation work in irrigation and drainage.

JAMES J. WALSH, who for twenty-one years had been associated with the late Howard C. Holmes, will continue the business as Mr. Holmes' successor under the name of the Howard C. Holmes Co., San Francisco, Cal.

DANIEL A. YOUNG has been appointed state engineer of Vermont succeeding Herbert M. McIntosh, resigned. Mr. Young was formerly an instructor in civil engineering at Union College, Schenectady, N. Y., but at the time of his appointment was with the state highway department of Vermont.

ALVA SMITH, for fifteen years city engineer of Emporia, Kan., has resigned. He plans to move to California.

JOHN W. LAYLE, superintendent of highways at Bridgeburg, Ont., has resigned to accept a similar position at Fort Erie, Ont.

D. H. KNIGHT of Kokomo, Ind. will succeed WILLIAM R. PAYNE, resigned, as city engineer of Frankfort, Ind.

E. R. THOMAS, city engineer of Port Arthur, Tex., has resigned. His successor has not yet been announced.

MORRIS A. ZOOK, for seven years resident engineer of the Bureau of Valuation, Interstate Commerce Commission, at Washington, has resigned to enter private practice in Plainfield, N. J.

J. F. PRICE, road supervisor of Venango Township, Erie Co., Pa., has resigned.

COL. WILLIAM BARCLAY PARSONS, Engr. O.R.C., has been appointed deputy chief engineer of G. H.Q. Engineer Headquarters of the organized reserves, U.S. Army. During the organization of the reserve forces following the World War, Col. Parsons commanded the 363rd Engineers, from which duty he is now relieved to take up the broader duties involved in his new assignment.

A. W. FUCHS was erroneously reported in *Engineering News-Record*, Feb. 16, to have resigned from the United States Public Health Service. The fact is that Mr. Fuchs is associate sanitary engineer for the service and has been detailed to make a malaria survey of the Missouri Pacific R.R.

COL. GEORGE L. WATSON, consulting engineer, New York, has incorporated his private practice with that of the George A. Johnson Co., consulting engineers, New York.

BUSINESS NOTES

THE PITTSBURGH TESTING LABORATORY announced at its annual meeting held in Pittsburgh Feb. 2 the retirement of its president, George H. Clapp, his reappointment as a member of the board of directors of the company and the election of Col. James Milliken to the presidency of the company. Col. Milliken, as a mechanical officer of the Pennsylvania R.R., has had wide experience in designing, constructing and shipping railroad equipment.

THE CONCRETE ENGINEERING CO., Omaha, Neb., has established a branch office at Dallas, Tex., in charge of Russell Jolley.

A. R. HANCE has succeeded L. T. RUSSELL as Northwestern sales manager for the Bucyrus Company with offices in Portland, Ore. Mr. Hance has been in the sales department of the company in the central and eastern territories for six years.

E. W. PITTMAN, president of Pittman-Smith Engineering Co., has been made general manager of the Penn Bridge Co., Beaver Falls, Pa.

LEO HUDSON, consulting engineer, and John P. Myron, formerly with the Pittsburgh Filter & Engineering Co., have formed a partnership under the name of Hudson & Myron, with offices located in the Wabash Building, Pittsburgh.

J. W. JOHNSTON, assistant general manager, Portland Cement Association, has been transferred from the Chicago headquarters to New York. His work in Chicago has been assumed by G. E. Warren, acting assistant general manager.

THE CHILLINGWORTH ENGINEERING CORPORATION announces that it has associated with it Frank H. Plum, Herbert Pluemer, George E. Mellin and Harold von Thaden, formerly of the C. W. Hunt Engineering Corp. and with the consent and approval of the Hunt organization will carry on a business of a character similar to that conducted by the Hunt corporation.

OBITUARY

W. K. STRINGFELLOW, for the past eight years city engineer of Findlay, Ohio, died Mar. 3.

MATTHEW FITZ GERALD, railroad contractor, who built the Oakland Avenue car line in Oakland, Cal., died Feb. 27.

H. E. STEVENS of Winston Bros., general contractors, Minneapolis, Minn., died at his home in St. Paul, Feb. 15. Mr. Stevens made the first survey of the Northern Pacific Ry. from Bismarck, N. D. to the Yellowstone Valley and later was superintendent of Shepard & Sons when they constructed the Great Northern Ry. in Minnesota and the Dakotas.

JOSEPH WOOD, director of the Pennsylvania R. R. and formerly first vice-president of the Pennsylvania Lines, West, died March 4 at his home in Pittsburgh. He was a graduate of the Pennsylvania Polytechnic College as a civil engineer, and immediately entered the employ of the Pennsylvania R.R. as a rodman. He progressed by rapid stages in the railroad service, becoming superintendent of motive power at Fort Wayne, Ind.; general superintendent of transportation of Pennsylvania Lines, West; general manager of Pennsylvania Lines, West; and later first vice-president of Lines West of Pittsburgh and president of the Vandalia Railway Co. and the Grand Rapids & Indiana Railway Co.

WILLIAM A. THOMAS, former superintendent of construction for the dock board, New Orleans, La., died recently at his home in New Orleans, aged 80 years. He had also served the city as expert in the building of levees along the Mississippi River.

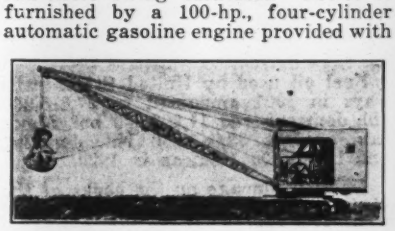
HENRY P. CORBIN, consulting engineer of the International Boundary Commission between the United States and Mexico, died at El Paso, Texas, Feb. 18.

FRANK H. CLEMENT, engineer and contractor, died at Palm Beach, Fla., Feb. 18. He was formerly with the engineering corps of the Texas Pacific R.R. and later with the Southern Pacific and Northern Pacific railroads. He had engaged in construction work on the Niagara Falls power tunnel, and was a director of the Giant Portland Cement Co.

EQUIPMENT AND MATERIALS

Gas Engine Crane-Excavator

A crane-excavator which will operate either a clamshell or a drag bucket is being manufactured by the Koehring Machine Co., Milwaukee, Wis. The new machine has a lifting capacity of 20 tons and handles a one-yard clamshell bucket, loaded, at 45-ft. radius. It is mounted on crawler tractions with a full-circle swing turntable. Power is furnished by a 100-hp., four-cylinder automatic gasoline engine provided with

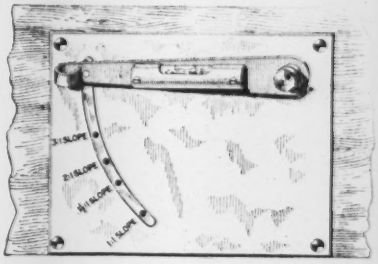


a fan-cooling system and air-distributing type self-starter.

The crane has three speeds, forward and reverse, and, in steering, use is made of a speed change differential, so that one side goes either faster or slower than the other side, when corners have to be turned. When the operator desires to change from clamshell operation to dragline work all that is necessary is to unhook the rope sockets of the clamshell cables from their drums, coil the cables up with the clamshell bucket and reeve in and hook fast the cables with the sockets for the dragline bucket. Another feature is a double drum with two cables for the boom hoist. The cables lead out over sheaves on each side of the boom and, after passing over the requisite number of sheaves to give the right number of parts of line, meet in an equalizer.

New Slope Level Device

A device for indicating slopes on construction work has been placed on the market by the David White Co. of Milwaukee. As shown in the accompanying drawing, it consists of a radial limb on which a spirit level tube is mounted



and an arc perforated with holes on which various slopes are indicated. The device may be attached to any straight-edge or board and the slopes secured by setting the arm at the notch specified and bringing the level bubble to the center of its tube.

A New Industrial Locomotive

A seven-ton gasoline locomotive has been developed by the Industrial Equipment Co., Minster, Ohio, formerly The Cummings Machine Co. It has an all-steel box-girder frame; special high-manganese-chrome alloy steel is used in the axles, jack shaft and friction-disc shaft, and Carnegie rolled-steel wheels

are used. The power unit is a Buda engine.

To insure maximum transmission of power and proper alignment of all working parts the engine and drive-disk assembly are combining in one complete unit with a two-point suspension, the recognized standard today in the automotive field.

A number of parts are eliminated by changing the method of braking. When the brake is applied two heavy iron shoes, diametrically opposite, grip a steel brake wheel on the jack shaft. With a pressure of approximately 25 lb. it is possible to lock the wheels. Another special feature is the stationary hand-wheel method of shifting the fibre wheel across the face of the disc in order to get forward, reverse, or change in speeds.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Rapid-Fire Survey of Business Conditions

Postal savings transactions in February showed a slight increase in deposits over withdrawals for the first time since January, 1921.

New bond issues offered last week exceeded $87,000,000, and by groups were as follows:

Foreign	$34,250,000
Public utility	8,710,000
Industrial	3,900,000
Railroad	12,025,000
State and municipal	23,774,000
Land Bank	4,800,000
Total	$87,459,000

The feature of the market was the Treasury Department's announcement of a new issue of four-year non-callable, tax-exempt 4¾-per cent certificates, to mature March, 1926, which may be acquired only through exchange of Victory 4¾s. Public utility financing was heavier than for any other week this year.

Call money was at 4@5½ per cent last week; time loans at 4¾@5. The present bond market is largely controlled by the money market, where funds are easy.

Business depression and unemployment will be studied at a conference of representatives of trade associations, Chamber of Commerce of the United States, Department of Labor, and the President's Unemployment Conference, called for March 21 by the Department of Commerce.

An economy minister for Germany, or a "minister to effect savings" is a demand by the Stinnes-Stressmann German People's Party that has been acceded to by the Wirth Government.

English wholesale prices declined, according to the Economist's index number, from 4,284 to 4,239, at the end of February, which is the lowest since July, 1916. Comparison of averages for the different groups is as follows:

	Mar. 1, 1922	Feb. 1, 1922	Mar. 1, 1921
Cereals and meat	948.0	907.5	1,176.5
Other food products	640.5	654.5	771.0
Textiles	1,037.5	1,066.5	1,038.0
Minerals	696.5	730.0	1,053.0
Miscellaneous	936.5	925.5	1,137.5
Total	4,239.0	4,284.0	5,176.0

French living cost is estimated to have decreased only 20 per cent since the closing months of 1920. Taking the first half of 1914 as 100, the total average cost of living was 370 in the first quarter of 1920, and 297 in the last quarter of 1921.

Retail food prices declined in seven of fifteen representative cities of the United States, according to the Bureau of Labor Statistics, as follows: Kansas City, 4 per cent; Louisville and Jacksonville, less than 0.5; Little Rock, Pittsburgh, Providence and Charleston, 1. In seven cities there were increases. Minneapolis and St. Paul, 2 per cent; Baltimore, Indianapolis, Milwaukee and St. Louis, 1; Detroit, less than 0.5. As compared with the average cost in the year 1913, the retail cost of food on Feb. 15, 1922, showed an increase of 47 per cent in Baltimore and Fall River; 46 in Providence; 45 in Detroit; 42 in Milwaukee; 40 in Minneapolis and St. Louis; 38 in Pittsburgh and Jacksonville; 37 in Indianapolis; 36 in Kansas City; 33 in Little Rock; and 31 in Louisville.

Pig iron output per day in gross tons has been at the following rates during each month since the end of the war.

	1922	1921	1920	1919
Jan.	53,063	77,945	97,264	106,525
Feb.	58,214	69,187	102,720	105,006
Mar.		51,468	108,900	99,685
Apr.		39,768	91,327	82,607
May		39,394	96,312	68,002
June		35,494	101,451	70,495
July		27,889	98,931	78,340
Aug.		30,780	101,529	88,496
Sept.		32,850	104,310	82,932
Oct.		40,005	106,212	60,115
Nov.		47,183	97,830	79,745
Dec.		53,196	87,222	84,944

Steel production is at the rate of approximately 20,000,000 gross tons a year, which is 3 per cent higher than the average rate of 1912 and 1913.

"Corner Turned in Birmingham" writes the assistant chief engineer of the Tennessee Coal, Iron & R.R. Co., who is Construction News correspondent in that city; "the Tennessee Co. has blown in two blast furnaces in the last two weeks that have been idle for a year and is preparing another for blast. Other companies are doing the same. Construction news should increase in quantity and value very shortly." Cast-iron pipe makers shipped 10,000 tons to the Pacific coast in January and have loaded 3,000 tons since then for the same destination. The Japanese Government ordered 14,000 tons of rails early this year and an additional 10,000 recently. Three cargoes have moved out of Mobile for Japan this year.

Petroleum output of the world for 1921 was 759,030,000 bbl., an increase of 9.2 per cent over 1920, according to the American Petroleum Institute. The following countries exceeded 10,000,000 bbl.:

	1000 Bbl. 1921	1000 Bbl. 1920
United States	469,639	443,402
Mexico	155,064	163,540
Russia	28,500	25,429
Dutch East Indies	18,000	17,529
Persia	14,600	12,352

Fuel oil used by United States railways in 1921 amounted to 27,615,000 bbl. domestic and 11,209,000 bbl. Mexican, against 33,986,000 bbl. domestic and 11,861,000 Mexican in 1920.

Unfilled tonnage on the books of the U. S. Steel Corporation at the close of February was 4,141,069, as compared with 4,241,678 at the close of January. This is the lowest figure reported since September, 1914.

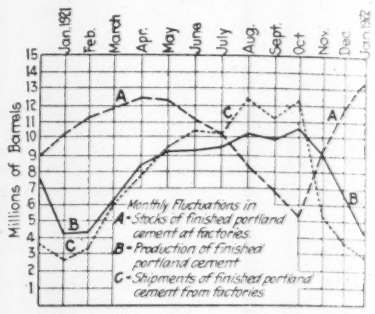
Employees doubled in number in Detroit industries since March 1, 1921, according to the Employers' Association. The increase from January, 1922, to February was 8,664.

Factory workers' earnings were $3.18 per week lower in January, 1922, than

(Concluded on p. 467)

Cement Output in 1921 and January, 1922

The statistics shown in the following table, prepared under the direction of F. F. Loughlin, of the United States Geological Survey, are based mainly on reports of producers of portland cement, but in part on estimates. These estimates were made necessary by



the lack of returns from three large producers. Production for January, 1922, was 46,000 bbl. fewer than in January, 1921; shipments, 290,000 bbl. more; stocks, 2,848,000 bbl. more.

PRODUCTION, SHIPMENTS, AND STOCKS OF FINISHED PORTLAND CEMENT IN JANUARY, 1922, AND IN 1921 BY MONTHS

Month 1921	Production (bbl.)	Shipments (bbl.)	Stocks at end of Month (bbl.)
January	4,098,000	2,539,000	10,300,000
February	4,379,000	3,331,000	11,400,000
March	6,763,000	6,221,000	12,000,000
First Quarter	15,240,000	12,091,000	33,700,000
April	8,651,000	7,919,000	12,600,000
May	9,281,000	9,488,000	12,450,000
June	9,296,000	10,577,000	11,150,000
Second Quarter	27,228,000	27,984,000	36,200,000
July	9,568,000	10,301,000	10,414,000
August	10,244,000	12,340,000	8,280,000
September	10,027,000	11,329,000	6,953,000
Third Quarter	29,839,000	33,970,000	25,647,000
October	10,506,000	12,114,000	5,348,000
November	8,921,000	5,195,000	9,091,000
December	6,559,000	3,697,000	11,938,000
Fourth Quarter	25,986,000	21,006,000	26,377,000
1921 total	98,293,000	95,051,000	121,924,000
1922			
January	4,052,000	2,829,000	13,148,000

The Bureau of Foreign and Domestic Commerce, of the Department of Commerce, reports that imports of hydraulic cement in January amounted to 17,036 bbl., valued at $37,595; the total for 1921 was 122,317 bbl. valued at $388,828. Exports of hydraulic cement in January were 70,725 bbl. valued at $204,899; total exports in 1921 were 1,181,014 bbl. valued at $4,276,986. The exports in January went to Cuba and the other West Indies, 21,097 bbl.; South America, 22,902 bbl.; Mexico, 13,651 bbl.; Central America, 12,367 bbl.; Canada, 231 bbl.; other countries, 477 bbl.

Next week—Earnings of well-known companies in 1922 *and* 1921 *tabulated.*

Car Surplus, Shortage and Freight Loading

The total revenue freight loaded for the week ending Feb. 18, 1922, was 780,924 cars, a decrease of 7,488 cars from the preceding week. This is the first decrease in loading for the year to date, the climb having been consistently upward since the holiday week ending Jan. 7. The reduction in the loading can probably be attributed very largely to the fact that Lincoln's birthday was celebrated as a holiday in many parts of the country. The decline affected nearly all commodities, with the exception of miscellaneous which gained 1,469 cars, and live stock, 53 cars.

The serviceable car surplus for the week ending Feb. 23 was 264,814 cars, a decrease from the preceding week of 13,667. Box and coal cars contribute about equally to this surplus, being 105,938 and 105,570, respectively.

Later reports show 417,964 freight cars idle on Feb. 28, compared with 437,678 on Feb. 23, or a reduction of 19,714.

Of this total, 245,100 were surplus freight cars in good repair and immediately available for service if traffic conditions had necessitated them being placed in use while the remaining 172,864 were freight cars in need of repairs in excess of the number normally regarded as being unfit for service because of their physical condition.

Surplus box cars in good repair totaled 95,361, a reduction since Feb. 23 of 10,577, while surplus coal cars in good order numbered 97,634, which was a reduction of 7,936 within the same period. Tabulations show a decrease in slightly less than a week of 1,018 in the number of surplus stock cars, the total being 19,955.

SURPLUS AND SHORTAGE STATEMENT—FEB. 15 TO 23, 1922

Districts	Flat Cars Surplus	Flat Cars Shortage	All Box Cars Surplus	All Box Cars Shortage	All Coal Cars Surplus	All Coal Cars Shortage	Total All Cars Surplus	Total All Cars Shortage
Eastern	2,185	.....	21,707	173	27,954	.....	54,785	197
Allegheny	2,135	.....	19,396	.....	48,559	.....	72,566	.....
Pocahontas	219	.....	1,257	.....	1,339	.....	4,326	.....
Southern	3,262	8	13,687	66	13,300	11	34,140	87
Northwestern	2,686	15	20,972	.....	2,415	.....	33,850	35
Central Western	2,189	.....	19,067	72	8,629	34	46,949	106
Southwestern	980	.....	9,852	62	3,374	.....	18,198	92
Total	13,656	23	105,938	373	105,570	45	264,814	517
Canadian Roads	5,100	.....	27,815	.....	275	.....	40,550	.....
Grand Total	18,756	23	133,753	373	105,845	45	305,364	517
Jan. 23, 1922	17,967	26	188,379	190	185,589	7	437,687	517

Cement Prices at Lehigh Mills

Cement quotations at mills of the Lehigh Portland Cement Co. arrived too late to be incorporated in the regular monthly price list in the Mar. 2 issue of *Engineering News-Record*. Current prices, in carload lots, to contractors, not including charge for bags, are based upon the following mill prices:

Mitchell, Ind.	$1.95
La Salle, Ill.	1.60
Iola, Kan.	1.95
Mason City, La.	1.95
Fordwick, Va.	1.95

Laborers Union in San Francisco Volunteers Wage Reduction

San Francisco street laborers of the United Laborers Union, No. 1, have voluntarily agreed to a wage reduction from $6 to $5 per day. This effects about 250 men in the employ of the city board of public works.

Open Shop Reported Successful in Dallas

No serious labor troubles have been encountered in Dallas, Tex., since the Open Shop Association has been operating. *Dallas*, the official publication of the Dallas Chamber of Commerce, reports that the organization has 1,000 members and placed 9,811 workers in 1921 with its free employment bureau. About $30,000,000 worth of building permits have been taken out in the last two years. At a recent meeting builders stated that a specification with an open-shop clause in the building contract was a guarantee that the structure would be built without delay and the owner would receive a full day's work for a full day's pay.

Review of Business Conditions

(Continued from p. 466)

in January last year, in New York state. Part time schedules and elmination of overtime brought down the average earnings to $24.34 per week.

Building permits in February 1921 and 1922 issued in four cities were:

	Feb. 1922	Feb. 1921
Syracuse, N. Y.	$178,520	$229,640
Rochester, N. Y.	376,215	390,358
Binghamton, N. Y.	134,307	48,138
Los Angeles, Cal.	7,579,798	3,131,670

Chicago permits in February numbered 634, of which 288 were for residences and 192 for apartments. This record exceeds the permits taken out in any previous February in the city's history. Permits for construction involving $21,485,350 were taken out in January and February.

Representative Public Bond Sales in February

Municipal bond sales in the United States, for the month of February, 1922, exceeded $67,000,000, as against $65,000,000 for February, 1921. Among the important issues of the month were: City of Philadelphia, Pa., $9,000,000 4.25s; Pittsburgh School District, Pa., $5,000,000 4.3s; State of Massachusetts, $4,000,000 4.023s@4.23s and State of Georgia, $3,000,000 6.85s. Following are some representative sales:

REPRESENTATIVE BOND SALES OF FEBRUARY, 1922

State	Purpose	Amount	Maturity	Rate Per Cent	Yield Per Cent	Sold For	Dated
Massachusetts	Water	32,000	1923—54	4½	3.91	103.089	Mar. 3, 1922
	Sewer	100,000	1922—61	4			
	Sewer	213,000	1922—59	4½			
	Park	230,000	1923—45	4½			
	Water	500,000	1923—62	4			
New Mexico *County*	Highway	1,000,000	1932—52	5	....	101.7946	Jan. 1, 1922
Acadia Parish, La.	Roads	177,000	.....	6	....	100.14	.....
Allen, Ind.	Hospital	140,000	1922—41	5½	5.23	102.028	Feb. 1, 1922
Baxter Creek Irr. District, Lassen Co., Calif.	Irrigation	511,000	.....	6	....	95.	.....
Benton Co. School Dist., Wash.	School Bldg.	20,000	Due yearly 1925—40	5½	....	100.10	Mar. 1, 1922
Chautauqua, N.Y.	Highway	250,000	$200,000 Apr., 1927 $ 50,000 Apr., 1928	5	4.34	102.968	Apr. 1, 1922
Clinton, Ind.	Hospital	100,000	.....	5	....	100.	Feb. 11, 1922
Decorah Independ. School District, Winneshiek Co., Ia.	School Bldg.	150,000	Due yearly 1923—41	5	4.87	101.16	Mar. 1, 1922
Dodge, Minn.	Highway	58,368	1941	4½	....	100.	Dec. 1, 1921
Erie, N. Y.	Penitentiary	500,000	1924—51	4½	4.18	104.072	Feb. 1, 1922
	Highway	345,000	1927—36				
Grand River Drainage Dis., Mo.	Drainage	600,000	.....	5½	....	96.40	.....
Hancock, Ohio	Ditch Imprv'mnt.	7,500	1923—26	6	....	100	Jan. 15, 1922
Isanti, Minn.	Drainage	38,500	1928—42	5	4.98	100.17	Mar. 1, 1921
Madison, No. Car.	Road	150,000	1952	6	....	102.95	.....
Paradise Irr. Dist., Butte Co., Calif.	Irrigation	140,000	.....	6	....	95.07	.....
Wake, No. Car.	Road and Bridge	390,000	$8,000—1925—38 $10,000—1939—43 $12,000—1944—62	5¼	5.16	101.17	Mar. 1, 1922
Washington, Utah. *Municipality*	Road	56,000	1932—42	5½	....	97.	Mar. 1, 1922
Atlanta, Ga.	Waterworks	400,000	1925—51	5	4.76	102.71	Jan. 1, 1922
	School	1,500,000					
	Sewer	400,000					
	Bridge	500,000					
Bristol, Conn.	Waterworks	200,000	1947	4½	4.16	105.279	Feb. 1, 1922
Buffalo, N.Y.	Municipal	28,000	1922—42	4	....	100.	Feb. 1, 1922
	Building Local work	8,669	1923				
Caldwell, Idaho	Sewer	38,903	.....	7	....	100	.....
Chandler, Ariz.	St. Imprvmt	93,612	1923—32	6	....	100.	Feb. 20, 1922
Cherryville, No. Car.	Local Improvem't.	110,000	$6,000—1925—34 $7,000—1935—40 $8,000—1941	6	....	100.	Mar. 1, 1922
Eldora, Ia.	Waterworks	40,000	.....	5	....	100	.....
Kenmore, Ohio	Sewers	29,000	1924—32	5½	5.45	100.25	Feb. 1, 1922
		22,000	1923—27	5½	5.43	100.06	
		12,000	1923—27	5½	5.43	100.06	
Lake Wales, Fla.	St. Imprvt.	200,000	.....	6	....	93.	Jan. 1, 1922
New Prague, Minn.	City Imprvt.	98,000	.....	6	....	100.	.....
Oneida, N. Y.	Sewer	5,245	1923—32	5	4.94	100.33	Feb. 1, 1922
Pelham, N. Y.	Park	92,000	1926—48	6	4.80	113.3108	Dec. 15, 1921
San Benito, Tex.	Paving	100,000	$2,000—1923—27 $4,000—1928—32 $6,000—1933—37 $8,000—1938—42 inc.	6	6.48	98.	Feb. 1, 1922
	Sewer	20,000	1922—61	6	6.18	98.	Aug. 1, 1921

Plumbing Contractors in Chicago Accept Landis Award

Fifty leading plumbing contractors in Chicago have signified their intention of operating their shops under the terms and wages of the Landis award. The rules posted in each shop state that the new agreement would go into effect Mar. 11, that all union rules and restrictions would be eliminated at that time and that any competent plumber would be employed regardless of his union affiliations. To establish the fact that union men will work with non-union men, one non-union man will be put to work to every five employees should the old employees remain at work.

The plumbers were in a position to hamper seriously many of the construction jobs which have been going on with the backing of the citizens committee to enforce the award. F. W. Armstrong, general manager of the citizens committee states that the action of the plumbers means $750,000 worth of new plumbing contracts.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted. Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section. The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of March 2; the next, on April 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.63	$3.25	$4.00	$2.63—$2.66		$3.50	$3.10	$3.25	$3.75
Structural rivets, 100 lb.	3.50	3.80	5.50	3.43	3.90	4.25	4.50	—3.75	6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	2.53	3.15	3.50	2.53	—2.56	3.42½	2.75	3.25	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	68%	45%	59½%	61.9-5%	44%	58.8%	53%	35.10
Cast-iron pipe, 6in. and over, ton	47.30@48.30	37.63	48.30	+43.10@44.60	46.00	52.00	48.00	+50.00	55.00
Concreting Material:									
Cement without bags, bbl.	+2.40	2.39	—2.25	1.94	2.24	2.90	2.73	2.94	2.40
Gravel, ¾ in., cu.yd.	1.75	1.85	+2.25	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.00	1.15	+2.25	2.00	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.75@1.85	1.90	—2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	49.00	37.00	34.00	43.00	38.00	34.75	—28.00	20.00	.....
Lime, finishing, hydrated, ton	15.80@16.80	18.00	25.00	18.00	29.00	24.00	22.00	27.00	21.00
Lime common, lump, per bbl.	2.75@3.48	1.25	2.50	1.40	1.40	2.70	1.75	2.75	11.00
Common brick, delivered, 1,000.	—19 40@19.90	8.75	+11.15	11.00	15.00	12.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.07975	—.115	.0821	.0752	.08	....	.10	.20
Hollow partition tile 4x12x12, block	.11120	.06525	—.115	.0657	....	.10	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.87	.94	+.109	.97	—.98	1.14	+1.06	.86	1.05
Common Labor:									
Common labor, union, hour	.60	.35	.....	.72½	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour.	.....	.20	—.25	.35@.40	.40@.50	.35@.40	.47½@.56	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump line per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net.

Montreal quotes sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 96.38 cents). Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

The minimum price of structural steel shapes and reinforcing bars, at the Pittsburgh mills, is practically confined to $1.40 per 100 lb. on large tonnages. The nominal quotation of $1.50 on the part of certain independent manufacturers has made it increasingly difficult to purchase at the recent price of $1.35 @$1.40. Steel shapes are quoted at $2.26 as against $2.91 in Minneapolis warehouses; reinforcing bars at $2.56 as compared with $2.81 per 100 lb. last week. Seattle quotes structural rivets at $3.75 reduced from $4 per 100 lb. Cast-iron pipe up $5 per ton in Seattle; slight advance in Chicago. Advance of $1 per M. ft. on Douglas fir in San Francisco. Linseed oil down 3c in Minneapolis and advanced 2c. per gal. (5 bbl. lots) in San Francisco.

Dealers' prices on portland cement in carload lots, f.o.b. Montreal, are quoted at $2.40 shipped by rail from the mill and at $2.45 per bbl. by tramway. Consumers' prices quoted at $2.70 f.o.b. railway siding and $2.73 f.o.b. tramway. Prices to consumers in less than carload lots are quoted at $3 per bbl. at the warehouse and $3.38 on the job. All prices are net, not including bag charges, discount for cash or Government sales tax.

A total of 386 mills reporting to the National Lumber Manufacturers' Association for the week ending Mar. 4, show 177,466,413 ft. of lumber cut; 176,745,070 ft. shipped and orders for 176,022,065 ft. b.m. Production stands at 25 per cent; shipments at 25½ per cent and orders at about 28 per cent below normal.

Seattle reports building construction greatly increased; unemployment situation also visibly improved during the last week. Common labor, non-union, is obtainable in Dallas at 25c. as against the old rate of 35c. per hr. Chicago building trades accept new wage cut.